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Attorneys for Plaintiffs
 Dyson Limited, Dyson Research
 Limited, and Dyson Technology
 Limited

UNITED STATES DISTRICT COURT
 NORTHERN DISTRICT OF CALIFORNIA

Dyson Limited, Dyson Research Limited,
 and Dyson Technology Limited,

Plaintiffs,

v.

BHN International LLC, dba Lava Heat
 Italia, Yaniv Zioni, Ben Zioni, and Meital
 Zioni,

Defendants.

Case No.

C13-4694

**COMPLAINT FOR DAMAGES AND
 INJUNCTIVE RELIEF**

1. Patent Infringement;
2. Copyright Infringement;
3. Trademark Infringement/Counterfeiting; and
4. False Designation of Origin and Unfair Competition

DEMAND FOR JURY TRIAL

Dyson Limited, Dyson Research Limited, and Dyson Technology Limited (all referred to collectively hereinafter as "Dyson") state and allege as follows for their complaint against defendants BHN International LLC, dba Lava Heat Italia ("Lava Heat"), Ben Zioni, Meital Zioni, and Yaniv Zioni (all referred to collectively hereinafter as "Defendants"). Ben Zioni, Meital Zioni and Yaniv Zioni may be referred to collectively hereinafter as the "Zionis."

FILED

OCT - 9 2013

RICHARD W. WIEKING
 CLERK, U.S. DISTRICT COURT
 NORTHERN DISTRICT OF CALIFORNIA
 OAKLAND

iss.
 (14)

JSC

JURISDICTION AND VENUE

Parties

1. Dyson Limited is a Private Limited Company organized and existing under the laws of England and Wales, with its principal place of business in Malmesbury, United Kingdom.

2. Dyson Research Limited is a Private Limited Company organized and existing under the laws of England and Wales, with its principal place of business in Malmesbury, United Kingdom.

3. Dyson Technology Limited is a Private Limited Company organized and existing under the laws of England and Wales, with its principal place of business in Malmesbury, United Kingdom.

4. Upon information and belief, Lava Heat is, and at all times relevant to this action was, a Nevada limited liability company, with its principal place of business in Vernon, California and doing business using the Internet and interstate mail.

5. Upon information and belief, Ben Zioni is, and at all times relevant to this action was, an individual residing in California, a managing member of Lava Heat, and doing business using the Internet and interstate mail.

6. Upon information and belief, Meital Zioni is, and at all times relevant to this action was, an individual, a managing member of Lava Heat, residing in California and doing business using the Internet and interstate mail.

7. Upon information and belief, Yaniv Zioni is, and at all times relevant to this action was, an individual residing in California, a managing member of Lava Heat, and doing business using the Internet and interstate mail.

8. Upon information and belief, the Zionis have at all times relevant hereto been members, owners, and/or agents of Lava Heat and otherwise control Lava Heat and personally participated in and/or had the right and ability to supervise, direct, and control the wrongful conduct alleged in this Complaint and derived financial benefit from that conduct.

Jurisdiction

Venue

Intradistrict Assignment

GENERAL ALLEGATIONS

14. Dyson is in the business of, and has made and continues to make substantial investments of time, effort, and expense in, either directly or through affiliates and/or contractors, designing, developing, testing, manufacturing, publishing, marketing, distributing, and selling bladeless fan products and technologies (“Dyson Products”). Dyson is a leading innovator and provider of bladeless fan products throughout the world and has gained a worldwide reputation for quality and reliability respecting its fan designs and technologies.

15. In connection with the Dyson Products, Dyson owns patents granted by the United States Patent and Trademark Office, copyrights that are the subject of registrations with the United States Copyright Office and trademarks that are the subject of registrations with the United States Patent and Trademark Office (“Dyson’s Intellectual Property Rights”).

16. Widespread sales of illegal copies of Dyson Products and unauthorized use of Dyson’s Intellectual Property Rights by Defendants and others have caused and continue to cause significant harm to Dyson, undermine Dyson’s investments in its products, diminish Dyson’s goodwill, and cause substantial harm to consumers who have been and continue to be falsely led to believe they are acquiring genuine Dyson Products.

17. Dyson brings this litigation as a result of certain actions and omissions by Defendants consummated through sales conducted over the Internet, including via the website accessible via the domain name www.lavaheat.com, other websites, through interstate commerce, and through the mail, namely Defendants’:

- (a) Unauthorized reproduction and/or distribution of certain Dyson Products;
- (b) Unauthorized use in commerce of certain of Dyson’s Intellectual Property Rights; and
- (c) Creation among members of the general public of both a likelihood of and actual confusion, mistake, and/or deception as to Defendants’ supposed affiliation, connection, and/or association with Dyson and the purported origin, sponsorship, and/or approval by Dyson of Defendants’ distributed goods and activities.

18. Defendants’ acts and omissions alleged herein were and continue to be undertaken willfully, intentionally, and maliciously and have caused and continue to cause substantial damage to Dyson. As prayed for below, Dyson respectfully requests that the Court enter an injunction against Defendants and award Dyson damages, costs, and attorney fees as allowed by statute.

DYSON’S PATENTS, COPYRIGHTS, AND TRADEMARKS

19. On April 26, 2011, U.S. Patent No. 7,931,449 (“the ‘449 patent”) was issued to Dyson Technology Limited (See Exhibit A hereto, incorporated herein by reference). On

1 November 8, 2011, U.S. Patent No. 8,052,379 (“the ‘379 patent”) was issued to Dyson
2 Technology Limited (See Exhibit B hereto, incorporated herein by reference). On January 10,
3 2012, U.S. Patent No. 8,092,166 (“the ‘166 patent”) was issued to Dyson Technology Limited
4 (See Exhibit C hereto, incorporated herein by reference). Dyson Technology Limited owned the
5 ‘449 patent, ‘379 patent, and ‘166 patent throughout the period of the Defendants’ infringing acts
6 and still owns each patent. The ‘449 patent, ‘379 patent, and ‘166 patent each describes and
7 broadly claims a bladeless fan assembly.

8 20. Upon information and belief, in violation of 35 U.S.C. § 271, Defendant Lava
9 Heat has manufactured, sold, offered for sale, and is currently manufacturing, selling and offering
10 for sale bladeless fans that embody the patented inventions identified in paragraph 19.

11 21. On August 9, 2011, U.S. Patent No. D643,098 (“the ‘098 patent”) was issued to
12 Dyson Limited (See Exhibit D hereto, incorporated herein by reference). On December 4, 2012,
13 U.S. Patent No. D672,023 (“the ‘023 patent”) was issued to Dyson Technology Limited (See
14 Exhibit E, incorporated herein by reference). Dyson Limited owned the ‘098 patent throughout
15 the period of the Defendants’ infringing acts and still owns each patent. Dyson Technology
16 Limited owned the ‘023 patent throughout the period of the Defendants’ infringing acts and still
17 owns each patent. The ‘098 patent and ‘023 patent each describes and broadly claims an
18 ornamental design for a fan heater.

19 22. Upon information and belief, in violation of 35 U.S.C. § 271, Defendant Lava
20 Heat has manufactured, sold, offered for sale, and is currently manufacturing, selling and offering
21 for sale fans that embody the patented designs identified in paragraph 21.

22 23. Dyson has complied with the statutory requirements of placing a notice of the ‘449
23 patent, ‘379 patent, ‘166 patent, ‘098 patent, and ‘023 patent (collectively the “Dyson Patents”)
24 on all fans it manufactures and sells and has given Defendants written notice of the infringement.

25 24. In connection with the distribution of the Dyson Products, Dyson has created
26 numerous images that are wholly original with Dyson and contain copyrightable subject matter
27 under the laws of the United States (the “Dyson Images”). Dyson Limited and Dyson Research
28 Limited have complied in all respects with the Copyright Act, secured the exclusive rights and

1 privileges in and to the copyrights in the Dyson Images (collectively the “Dyson Copyrights”),
 2 and possessed Certificates of Registration for the Dyson Copyrights as granted by the Register of
 3 Copyrights (See Exhibit F hereto, incorporated herein by reference).

4 25. The Dyson Images have been published and distributed by Dyson or under its
 5 authority in compliance with the Copyright Act. Dyson has thus fully maintained the validity of
 6 the Dyson Copyrights.

7 26. At all relevant times, Dyson has owned trademarks, including without limitation
 8 Air Multiplier® (the “Dyson Trademark”), registered in accordance with the Lanham Act with the
 9 United States Patent and Trademark Office from which Dyson has received a Certificate of
 10 Registration, Reg. No. 3,930,474, registered on March 15, 2011.

11 27. Dyson has continuously used the Dyson Trademark from the date of registration
 12 thereof, or earlier, until the present and at all times relevant to the claims alleged herein. As a
 13 result of extensive use, advertising, and sales, together with longstanding consumer acceptance,
 14 the Dyson Trademark identifies to consumers and the public that Dyson is the source of origin for
 15 authorized copies of the Dyson Products. Throughout the United States and the world, the Dyson
 16 Trademark has acquired secondary meaning in the minds of consumers who associate the Dyson
 17 Trademark with Dyson and its quality products. By virtue of Dyson’s widespread advertising and
 18 distribution of the Dyson Products in connection with the Dyson Trademark, together with
 19 consumer acceptance and recognition, the Dyson Trademark identifies Dyson and the Dyson
 20 Products and distinguishes the same from, respectively, other entities and individuals and their
 21 products. The Dyson Trademark has become, and is, a valuable asset symbolizing Dyson, its
 22 quality goods, and its goodwill.

23 28. Dyson has never authorized Defendants to: (a) copy, reproduce, or distribute the
 24 Dyson Products; or (b) use any of the Dyson Intellectual Property Rights in connection with the
 25 advertising, sale, or distribution of the Dyson Products or otherwise.

26 **The Business And Infringing Activities Of Defendants**

27 29. Upon information and belief, without Dyson’s authorization, Defendants and/or
 28 their agents have:

- 1 (a) Copied, reproduced, and/or distributed one or more of Dyson's Products;
- 2 (b) Used various websites, mail, and interstate commerce to advertise, sell, and
- 3 distribute unauthorized copies of one or more of Dyson Products to consumers throughout the
- 4 United States, including in California and in this District;
- 5 (c) Used in commerce the Dyson Trademark;
- 6 (d) Used in commerce the Dyson Copyrights; and
- 7 (e) Created among the general public a likelihood of and/or actual confusion,
- 8 mistake, and/or deception as to Defendants' supposed (but non-existent) affiliation, connection,
- 9 and/or association with Dyson and/or the purported (but also non-existent) origin, sponsorship,
- 10 and/or approval by Dyson of Defendants' distributed goods and activities.

11 30. Upon information and belief, Defendants have had actual notice of Dyson's
 12 Intellectual Property Rights and Defendants' infringement of Dyson's Intellectual Property Rights
 13 since at least March 2012 when Dyson contacted Defendants through counsel. Despite
 14 Defendants' knowledge of the infringement, Defendants have continued to copy, reproduce,
 15 distribute, advertise, and sell products that infringe Dyson's Intellectual Property Rights.

16 31. Upon information and belief, Defendants have willfully, intentionally, and
 17 maliciously engaged in the acts and omissions alleged herein without regard to Dyson's
 18 proprietary rights.

19 **FIRST CLAIM FOR RELIEF**

20 **(Patent Infringement Against Lava Heat)**

21 32. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations
 22 of paragraphs 1 through 31 above.

23 33. Upon information and belief, the use of bladeless fan assembly is covered by the
 24 claims of the '449 patent. By using, selling and offering for sale bladeless fans, Lava Heat has
 25 committed direct, contributory and inducement of infringement of one or more claims of the '449
 26 patent.

27 34. As a result of the infringing activities of Lava Heat, Dyson has been and continues
 28 to be damaged, and suffers irreparable injury. Dyson has no adequate remedy at law against Lava

Heat's acts of infringement and Dyson will suffer irreparable harm unless Lava Heat is permanently enjoined from its infringement of the '449 patent.

35. Upon information and belief, Lava Heat has willfully infringed the '449 patent, making this an exceptional case and justifying the assessment of treble damages pursuant to 35 U.S.C. § 284 and attorney fees pursuant to 35 U.S.C. § 285.

WHEREFORE, Dyson seeks relief as set forth below.

SECOND CLAIM FOR RELIEF

(Patent Infringement Against Lava Heat)

36. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 through 31 above.

37. Upon information and belief, the use of bladeless fan assembly is covered by the claims of the '379 patent. By using, selling and offering for sale bladeless fans, Lava Heat has committed direct, contributory and inducement of infringement of one or more claims of the '379 patent.

38. As a result of the infringing activities of Lava Heat, Dyson has been and continues to be damaged, and suffers irreparable injury. Dyson has no adequate remedy at law against Lava Heat's acts of infringement and Dyson will suffer irreparable harm unless Lava Heat is permanently enjoined from its infringement of the '379 patent.

39. Upon information and belief, Lava Heat has willfully infringed the '379 patent, making this an exceptional case and justifying the assessment of treble damages pursuant to 35 U.S.C. § 284 and attorney fees pursuant to 35 U.S.C. § 285.

WHEREFORE, Dyson seeks relief as set forth below.

THIRD CLAIM FOR RELIEF

(Patent Infringement Against Lava Heat)

40. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 through 31 above.

41. Upon information and belief, the use of bladeless fan assembly is covered by the claims of the '166 patent. By using, selling and offering for sale bladeless fans, Lava Heat has

1 committed direct, contributory and inducement of infringement of one or more claims of the '166
2 patent.

3 42. As a result of the infringing activities of Lava Heat, Dyson has been and continues
4 to be damaged, and suffers irreparable injury. Dyson has no adequate remedy at law against Lava
5 Heat's acts of infringement and Dyson will suffer irreparable harm unless Lava Heat is
6 permanently enjoined from its infringement of the '166 patent.

7 43. Upon information and belief, Lava Heat has willfully infringed the '166 patent,
8 making this an exceptional case and justifying the assessment of treble damages pursuant to 35
9 U.S.C. § 284 and attorney fees pursuant to 35 U.S.C. § 285.

10 WHEREFORE, Dyson seeks relief as set forth below.

11 **FOURTH CLAIM FOR RELIEF**

12 **(Patent Infringement Against Lava Heat)**

13 44. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations
14 of paragraphs 1 through 31 above.

15 45. Upon information and belief, the use of the ornamental design for a fan is covered
16 by the claims of the '098 patent. By using, selling and offering for sale bladeless fans, Lava Heat
17 has committed direct, contributory and inducement of infringement of one of more claims of the
18 '098 patent.

19 46. As a result of the infringing activities of Lava Heat, Dyson has been and continues
20 to be damaged, and suffers irreparable injury. Dyson has no adequate remedy at law against Lava
21 Heat's acts of infringement and Dyson will suffer irreparable harm unless Lava Heat is
22 permanently enjoined from its infringement of the '098 patent.

23 47. Upon information and belief, Lava Heat has willfully infringed the '098 patent,
24 making this an exceptional case and justifying the assessment of treble damages pursuant to 35
25 U.S.C. § 284 and attorney fees pursuant to 35 U.S.C. § 285.

26 WHEREFORE, Dyson seeks relief as set forth below.
27
28

FIFTH CLAIM FOR RELIEF

(Patent Infringement Against Lava Heat)

48. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 through 31 above.

49. Upon information and belief, the use of the ornamental design for a fan is covered by the claims of the '023 patent. By using, selling and offering for sale bladeless fans, Lava Heat has committed direct, contributory and inducement of infringement of one of more claims of the '023 patent.

50. As a result of the infringing activities of Lava Heat, Dyson has been and continues to be damaged, and suffers irreparable injury. Dyson has no adequate remedy at law against Lava Heat's acts of infringement and Dyson will suffer irreparable harm unless Lava Heat is permanently enjoined from its infringement of the '023 patent.

51. Upon information and belief, Lava Heat has willfully infringed the '023 patent, making this an exceptional case and justifying the assessment of treble damages pursuant to 35 U.S.C. § 284 and attorney fees pursuant to 35 U.S.C. § 285.

WHEREFORE, Dyson seeks relief as set forth below.

SIXTH CLAIM FOR RELIEF

(Copyright Infringement Against All Defendants)

52. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 through 31 above.

53. Defendants' acts and omissions constitute willful, intentional, and malicious infringement of the Dyson Copyrights in violation of the Copyright Act, 17 U.S.C. § 501.

54. Defendants' willful, intentional, and malicious copyright infringement has caused and will continue to cause Dyson to suffer substantial injuries, loss, and damage to its proprietary and exclusive rights to the Dyson Products and the Dyson Copyrights and has caused and will continue to cause Dyson to lose profits in an amount not yet ascertained.

55. Defendants' copyright infringement, and the threat of continuing infringement by Defendants, have caused and will continue to cause Dyson to suffer repeated and irreparable

1 injury. It would be difficult to ascertain the amount of money damages that would afford Dyson
 2 adequate relief at law for Defendants' continuing acts and omissions alleged herein and a
 3 multiplicity of judicial proceedings would be required. Dyson's remedy at law is not adequate to
 4 compensate Dyson for the injuries already inflicted and further threatened by Defendants.
 5 Therefore, Defendants should be restrained and enjoined as authorized by the Copyright Act, 17
 6 U.S.C. § 502.

7 WHEREFORE, Dyson seeks relief as set forth below.

8 **SEVENTH CLAIM FOR RELIEF**

9 **(Trademark Infringement and Counterfeiting Against All Defendants)**

10 56. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations
 11 of paragraphs 1 through 31 above.

12 57. Defendants' acts and omissions alleged herein constitute willful, intentional, and
 13 malicious infringement of the Dyson Trademark in violation of Sections 32(1) and 43(a) of the
 14 Lanham Act, 15 U.S.C. §§ 1114(1) and 1125(a).

15 58. Upon information and belief, Defendants' infringing acts and omissions alleged
 16 herein have caused and will continue to cause a likelihood of, and actual, confusion, mistake,
 17 and/or deception among consumers as to the source, quality, and/or nature of the unauthorized,
 18 unlicensed, and infringing copies of Dyson Products made, advertised, sold, and/or distributed by
 19 Defendants (collectively, "Defendants' Products").

20 59. Upon information and belief, Defendants' unauthorized use of the Dyson
 21 Trademark competes directly with Dyson's distribution of authorized copies of Dyson Products,
 22 diverts trade from Dyson, and diminishes Dyson's goodwill.

23 60. Upon information and belief, Defendants' infringing acts and omissions have led
 24 and are likely to continue to lead consumers to erroneously believe that Defendants' Products are
 25 being offered for distribution by Dyson or with Dyson's authorization.

26 61. Upon information and belief, Defendants' use of the Dyson Trademark on the
 27 Internet, in the mail, in marketing materials, and/or on unauthorized copies of Dyson Products has
 28 caused and is likely to continue to cause confusion amongst consumers, threatens injury to

1 Dyson's business reputation and the goodwill associated with the Dyson Trademark, and
2 constitutes fraud on the public.

3 62. Upon information and belief: (a) Defendants have used reproductions,
4 counterfeits, copies, and/or colorable imitations of the Dyson Trademark in commerce in
5 connection with Defendants' distribution of bladeless fans that are unauthorized copies of Dyson
6 Products; (b) Defendants used the Dyson Trademark knowing such use was counterfeit; and (c)
7 Defendants' counterfeit use of the Dyson Trademark was in connection with the same categories
8 of goods or services covered by Dyson's federal registrations of its trademark as maintained by
9 the United States Patent and Trademark Office.

10 63. Upon information and belief, Defendants' actions have created and will continue
11 to create among members of the general public a likelihood of and/or actual confusion, mistake,
12 and/or deception as to Defendants' purported affiliation, connection, and/or association with
13 Dyson and as to the purported origin, sponsorship, and/or approval by Dyson of Defendants'
14 Products.

15 64. Upon information and belief, as a result of Defendants' willful, intentional, and
16 malicious infringement and counterfeiting of the Dyson Trademark, Dyson has suffered damage
17 to its business reputation and goodwill, a diversion of trade, and a loss of profits, all in an amount
18 not yet ascertained and for which Dyson is entitled to recover damages pursuant to 15 U.S.C. §
19 1117.

20 65. Defendants' trademark infringement and counterfeiting, and the threat of
21 continuing infringement and counterfeiting, have caused and will continue to cause Dyson
22 repeated and irreparable injury. It would be difficult to ascertain the amount of money damages
23 that would afford Dyson adequate relief at law for Defendants' continuing acts and omissions and
24 a multiplicity of judicial proceedings would be required. Dyson's remedy at law is not adequate
25 to compensate Dyson for the injuries already inflicted and further threatened by Defendants.
26 Therefore, Defendants should be restrained and enjoined as authorized by the Lanham Act, 15
27 U.S.C. § 1116.

28 WHEREFORE, Dyson seeks relief as set forth below.

EIGHTH CLAIM FOR RELIEF

(False Designation of Origin and False Descriptions Against All Defendants)

66. Dyson hereby incorporates by reference, as if fully set forth herein, the allegations of paragraphs 1 through 31 and 57 through 65 above.

67. Defendants' acts and omissions alleged herein were undertaken willfully, intentionally, and with malice and subject Defendants to liability under Section 43(a) of the Lanham Act, 15 U.S.C. § 1125(a).

68. Upon information and belief, Defendants, in connection with Defendants' Products, have in interstate commerce: (i) used the Dyson Trademark; (ii) falsely designated the origin of Defendants' Products; (iii) made misleading descriptions of fact concerning Defendants' Products; and/or (iv) made false or misleading representations of fact concerning Defendants' Products.

69. Upon information and belief, Defendants' acts and omissions alleged herein have caused and are likely to continue to cause confusion, or to cause mistake, or to deceive as to the affiliation, connection, or association of Defendants with Dyson, or as to the origin, sponsorship, or approval of Defendants' Products.

70. Upon information and belief, Defendants' acts and omissions alleged herein have been done and continue to be done in connection with commercial advertising or promotion and misrepresent the nature, characteristics, qualities, or geographic origin of Defendants' Products and Dyson Products.

71. Defendants' willful, intentional, and malicious acts and omissions alleged herein constitute false designations of origin, false descriptions, false advertising, and unfair competition with Dyson, and as a result thereof Dyson has suffered and will continue to suffer damage to its business reputation and goodwill, a diversion of trade, and a loss of profits, all in an amount not yet ascertained and for which Dyson is entitled to recover damages pursuant to 15 U.S.C. § 1117.

72. Defendants' false designations of origin, false descriptions, false advertising, and unfair competition, and the threat of continuing false designations of origin, false descriptions, false advertising, and unfair competition, have caused and will continue to cause Dyson repeated

1 and irreparable injury. It would be difficult to ascertain the amount of money damages that would
 2 afford Dyson adequate relief at law for Defendants' continuing acts, and a multiplicity of judicial
 3 proceedings would be required. Dyson's remedy at law is not adequate to compensate Dyson for
 4 the injuries already inflicted and further threatened by Defendants. Therefore, Defendants should
 5 be restrained and enjoined as authorized by the Lanham Act, including without limitation 15
 6 U.S.C. § 1116.

7 **PRAYER FOR RELIEF**

8 WHEREFORE, Dyson seeks relief as follows:

9 73. That the '449 patent, '379 patent, '166 patent, '098 patent, and '023 patent be
 10 adjudged to be valid and infringed by Lava Heat;

11 74. That a permanent injunction issue against continued infringement of the '449
 12 patent, '379 patent, '166 patent, '098 patent, and '023 patent by Lava Heat, its subsidiaries,
 13 employees, agents, affiliates, consultants and contractors, the Zionis, and all those in privity or
 14 acting in concert with Defendants, including but not limited to an injunction against the
 15 manufacture, use, sale and/or distribution of bladeless fans that infringe the Dyson Products.

16 75. That Dyson be awarded its lost profits as damages for Lava Heat's infringement of
 17 the '449 patent, '379 patent, '166 patent, '098 patent, and '023 patent and that such damages be
 18 trebled under 35 U.S.C. § 284 due to the willful and deliberate character of this infringement;

19 76. That, upon motion, the Court issue a preliminary injunction enjoining and
 20 restraining Defendants, and each of them, and their respective agents, servants, employees,
 21 successors and assigns, and all other persons acting in concert or conspiracy with Defendants or
 22 affiliated with Defendants, from:

23 (a) Copying, reproducing, distributing, or using any unauthorized copies of
 24 Dyson Products;

25 (b) Otherwise infringing any of Dyson's copyrights;

26 (c) Copying, reproducing, advertising, offering for sale, distributing, or using
 27 any goods or services in connection with any of Dyson's trademarks or any other marks
 28 confusingly similar thereto;

(d) Using in any manner any of Dyson's trademarks, any marks confusingly similar thereto, or reproductions, counterfeits, copies, or colorable imitations thereof in connection with any of Defendants' goods or services in such a manner that is likely to create the erroneous belief that said goods or services are authorized by, sponsored by, licensed by, or are in some way associated with Dyson;

(e) Otherwise infringing any of Dyson's trademarks; and

(f) Destroying, otherwise disposing of, or altering any copies of products or other products, materials, technologies, services, devices, components, documents, or electronically stored data or files that relate or pertain in any way to the:

(i) Copying, reproduction, distribution, or use of Dyson's Products;

(ii) Use of Dyson's trademarks, any marks confusingly similar thereto, or reproductions, counterfeits, copies, or colorable imitations thereof on or in connection with the advertisement, sale, or distribution of goods or services; or

(iii) Infringement of Dyson's copyrights or trademarks.

77. That the Court issue a permanent injunction making permanent the orders requested in paragraphs 76(a) through (e) of this Prayer For Relief;

78. That, upon motion, the Court issue a preliminary injunction ordering the impounding of all copies in Defendants' possession of items containing Dyson's copyrighted products made or used in violation of Dyson's rights, as set forth in the Copyright Act, 17 U.S.C. § 503(a);

79. That Dyson be awarded for Defendants' willful, intentional, and malicious copyright infringement either: (i) actual damages in an amount to be determined at trial, together with the profits derived from Defendants' infringement of Dyson's copyrighted software products; or (ii) statutory damages for each act of infringement in an amount provided by law, as set forth in 17 U.S.C. § 504, at Dyson's election before the entry of a final judgment;

80. That Dyson be awarded for Defendants' willful, intentional, and malicious trademark infringement, false designations of origin, false descriptions, false advertising, and unfair competition, as set forth in 15 U.S.C. § 1117(a), the profits obtained by Defendants and the

1 damages sustained by Dyson by reason of Defendants' acts and omissions alleged herein, and that
2 such amounts be trebled pursuant to 15 U.S.C. § 1117(b);

3 81. That Dyson be awarded for Defendants' willful, intentional, and malicious
4 trademark counterfeiting, as set forth in 15 U.S.C. § 1117(c), and at Dyson's election before the
5 entry of the final judgment, either: (i) actual damages in an amount to be determined at trial,
6 together with Defendants' profits derived from the unlawful counterfeiting of Dyson's registered
7 trademarks; or (ii) statutory damages for each registered trademark in an amount provided by law;

8 82. That the Court issue an order upon entry of judgment in this action requiring
9 Defendants to destroy any and all infringing copies in Defendant's possession, custody, or control
10 of Dyson's Images, as set forth by the Copyright Act, 17 U.S.C. § 503(b);

11 83. That the Court issue an order upon entry of judgment in this action requiring the
12 destruction, as set forth by the Lanham Act, 15 U.S.C. § 1118, of: (i) all labels, signs, prints,
13 packages, wrappers, receptacles, and advertisements in the possession of Defendants bearing any
14 of Dyson's registered trademarks; (ii) any materials containing false designations of origin, false
15 descriptions, or misrepresentations of fact concerning Dyson's Products or Defendants' Products;
16 (iii) any materials bearing any reproduction, counterfeit, copy, or colorable imitation of Dyson's
17 registered trademarks; and (iv) all plates, molds, matrices, and other means of making the same.

18 84. That the Court issue an order requiring Defendants to serve on Dyson, within
19 thirty (30) days after issuance of the injunction requested above, a report, in writing, under oath,
20 setting forth in detail the manner and form in which Defendants have complied with the
21 injunction;

22 85. For an award of prejudgment interest, and post-judgment interest, on the above
23 damages award;

24 86. For an award of costs and reasonable attorney fees under 35 U.S.C. § 285, 17
25 U.S.C. §§ 505, and 15 U.S.C. § 1117(a)(3) and other applicable laws; and

26 87. For such other and further relief, at law and in equity, as the Court may deem just
27 and proper.
28

1 Dated: October 9th, 2013

DONAHUE GALLAGHER WOODS LLP

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3 By: Julie E. Hofer
4 Julie E. Hofer
5 Attorneys for Plaintiffs
6 Dyson Limited, Dyson Research Limited,
7 and Dyson Technology Limited

8 **DEMAND FOR JURY TRIAL**

9 Plaintiffs hereby request a jury trial on all issues set forth herein.

10 Dated: October 9th, 2013

DONAHUE GALLAGHER WOODS LLP

11
12 By: Julie E. Hofer
13 Julie E. Hofer
14 Attorneys for Plaintiffs
15 Dyson Limited, Dyson Research Limited,
16 and Dyson Technology Limited
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EXHIBIT A



US007931449B2

(12) **United States Patent**
Fitton et al.

(10) **Patent No.:** **US 7,931,449 B2**
(45) **Date of Patent:** **Apr. 26, 2011**

(54) **FAN**

(75) **Inventors:** **Nicholas Gerald Fitton**, Wiltshire (GB);
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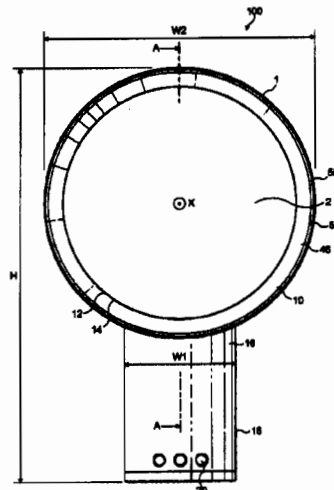
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(57) **ABSTRACT**

A bladeless fan assembly (100) for creating an air current comprises a nozzle (1) mounted on a base (16) housing for creating an air flow through the nozzle (1). The nozzle (1) comprises an interior passage (10) for receiving the air flow from the base (16) and a mouth (12) through which the air flow is emitted. The nozzle (1) extends about an axis to define an opening (2) through which air from outside the fan assembly (100) is drawn by the air flow emitted from the mouth (12). The nozzle (1) comprises a surface over which the mouth (12) is arranged to direct the air flow. The surface comprises a diffuser portion (46) tapering away from the axis, and a guide portion (48) downstream from the diffuser portion (46) and angled thereto.

16 Claims, 5 Drawing Sheets



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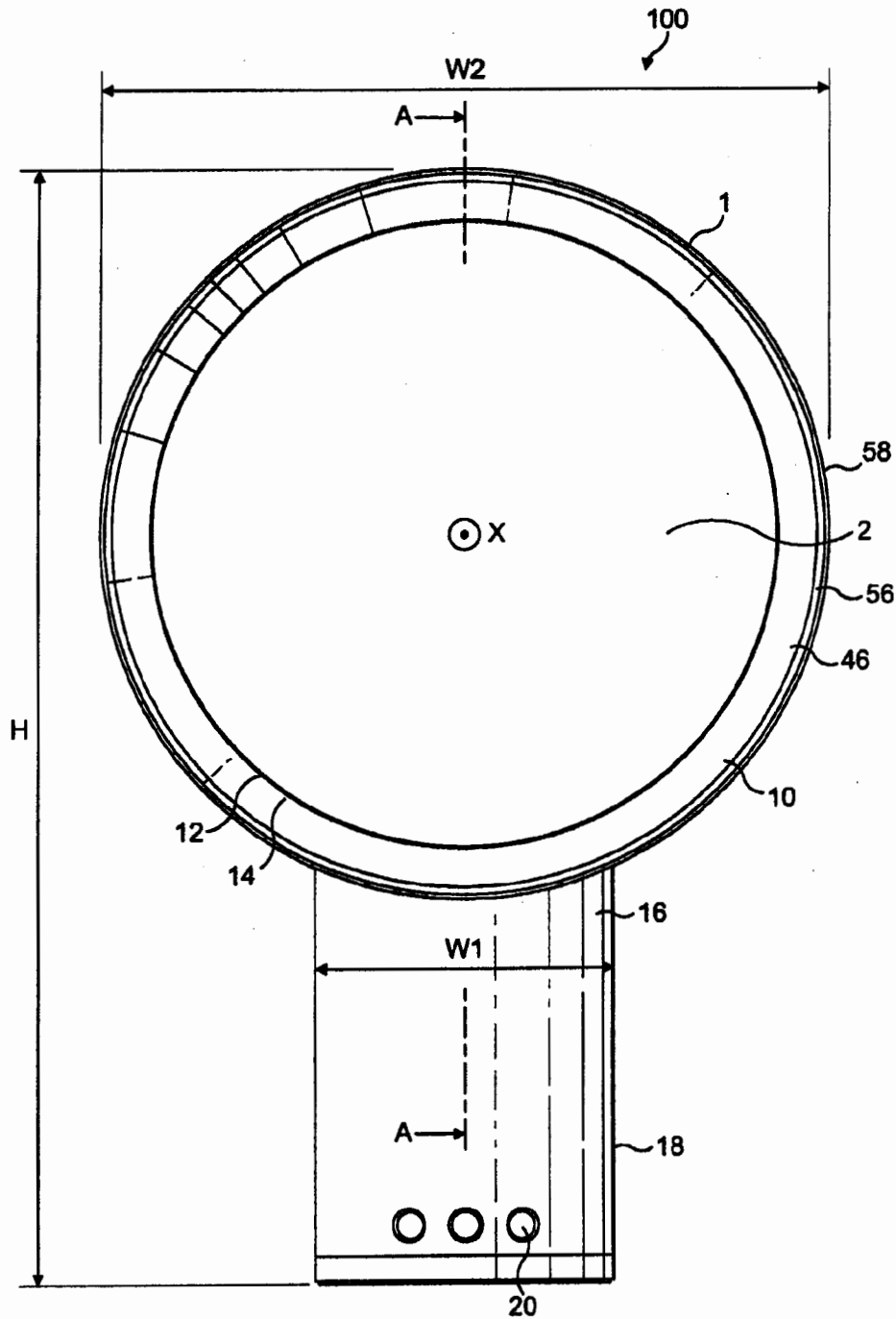


FIG. 1

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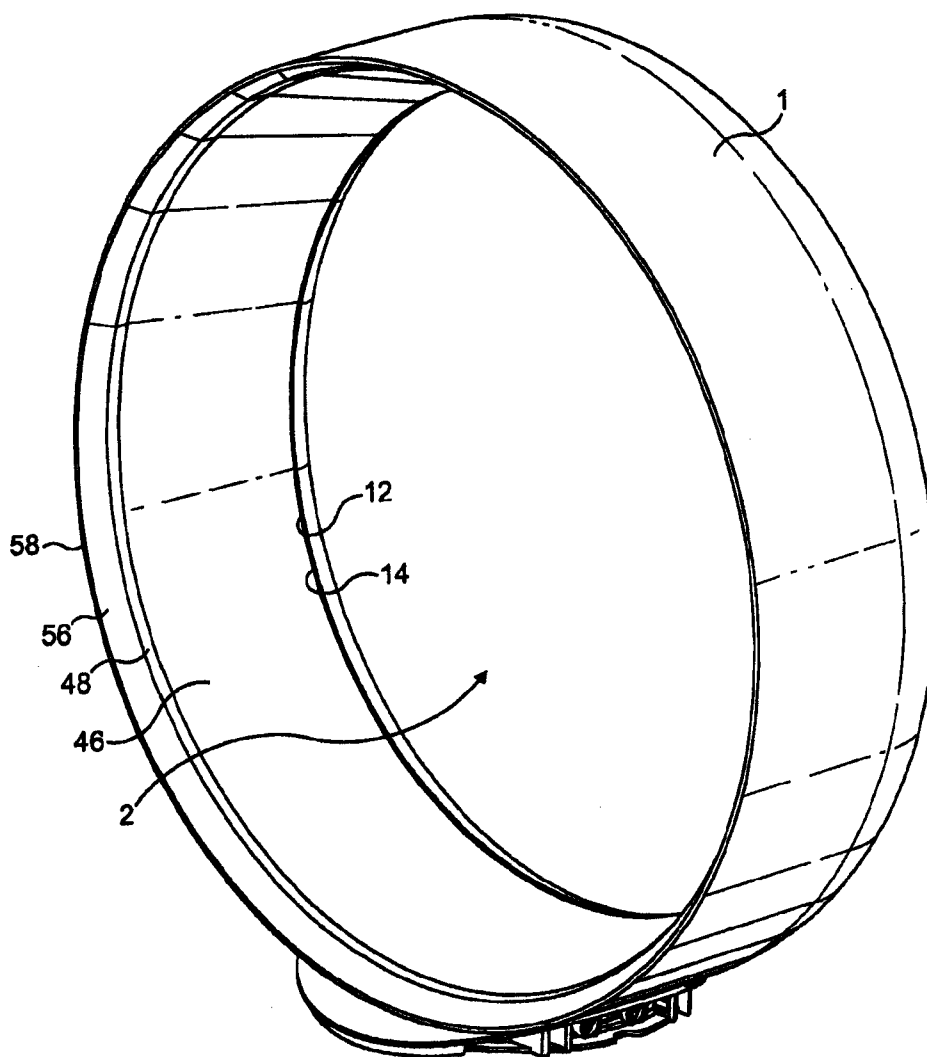


FIG. 2



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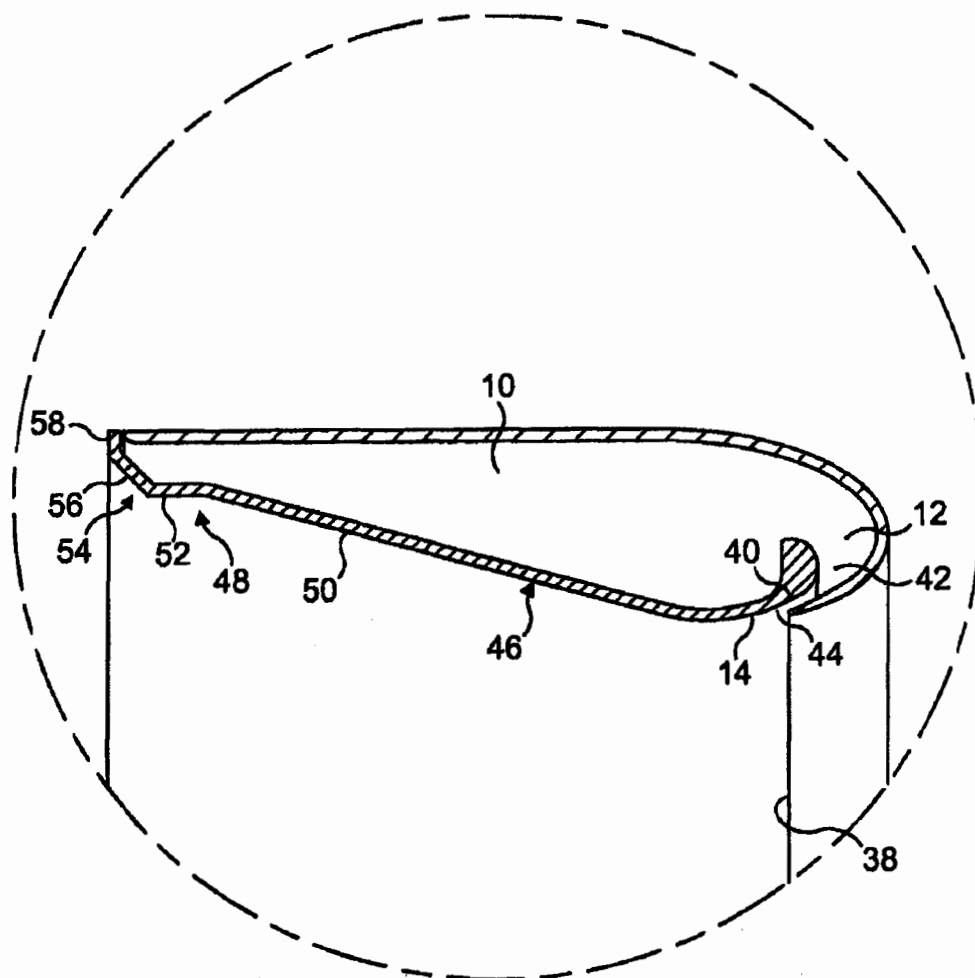


FIG. 4

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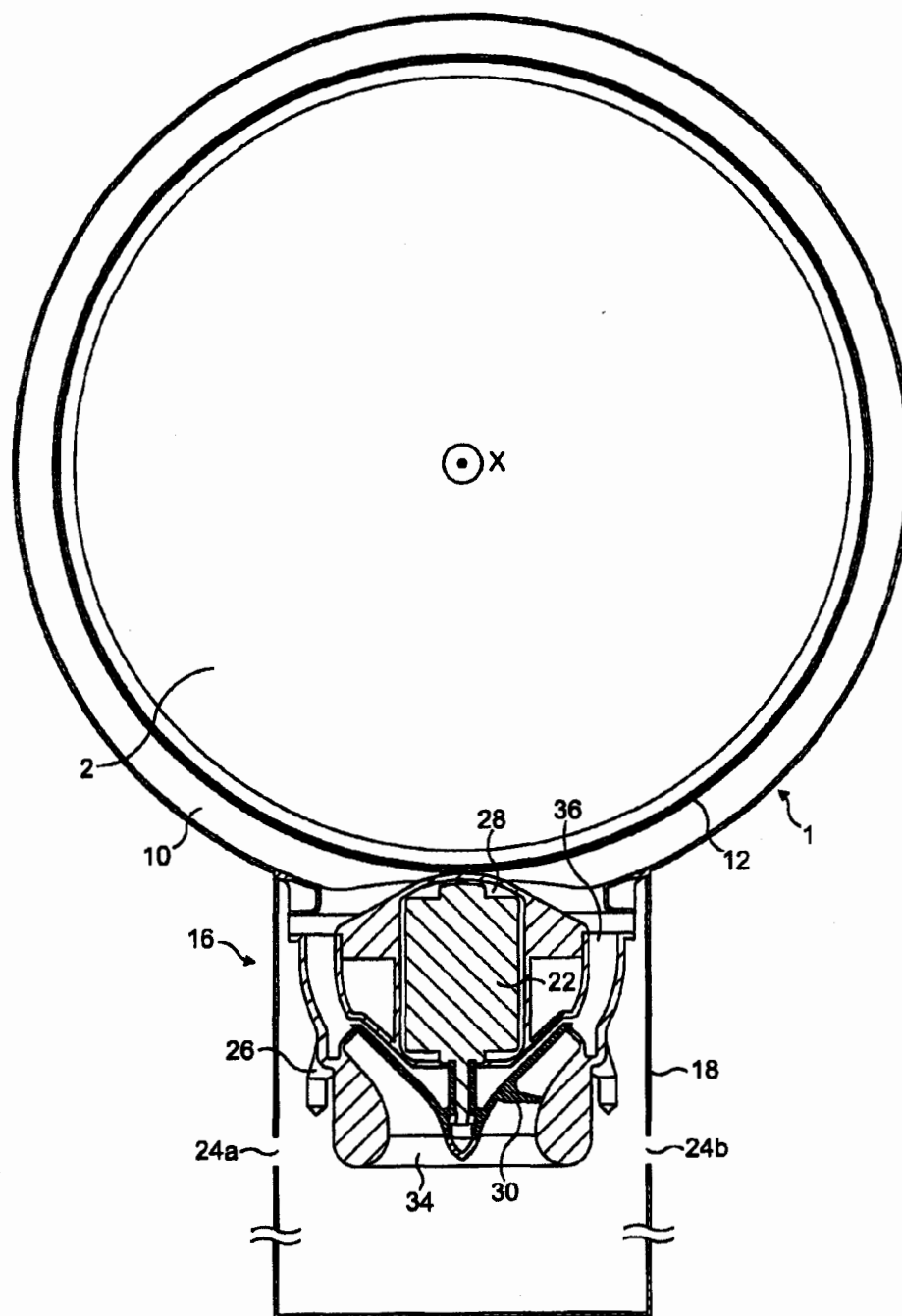


FIG. 5

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FAN

The present invention relates to a fan assembly. In its preferred embodiment, the present invention relates to a domestic fan, such as a desk fan, for creating air circulation and air current in a room, in an office or other domestic environment.

A conventional domestic fan typically includes a set of blades or vanes mounted for rotation about an axis, and drive apparatus for rotating the set of blades to generate an air flow. The movement and circulation of the air flow creates a 'wind chill' or breeze and, as a result, the user experiences a cooling effect as heat is dissipated through convection and evaporation. Such fans are available in a variety of sizes and shapes. For example, a ceiling fan can be at least 1 m in diameter, and is usually mounted in a suspended manner from the ceiling to provide a downward flow of air to cool a room. On the other hand, desk fans are often around 30 cm in diameter, and are usually free standing and portable.

A disadvantage of this type of arrangement is that the forward flow of air current produced by the rotating blades of the fan is not felt uniformly by the user. This is due to variations across the blade surface or across the outward facing surface of the fan. Uneven or 'choppy' air flow can be felt as a series of pulses or blasts of air and can be noisy. A further disadvantage is that the cooling effect created by the fan diminishes with distance from the user and the user may not be situated at the location or distance where it is possible to feel the greatest cooling effect. This means that the fan must be placed in close proximity to the user in order for the user to receive the benefit of the fan.

Other types of fan are described in U.S. Pat. Nos. 2,488, 467, 2,433,795 and JP 56-167897. The fan of U.S. Pat. No. 2,433,795 has spiral slots in a rotating shroud instead of fan blades. The circulator fan disclosed in U.S. Pat. No. 2,488, 467 emits air flow from a series of nozzles and has a large base including a motor and a blower or fan for creating the air flow.

In a domestic environment it is desirable for appliances to be as small and compact as possible due to space restrictions. For example, the base of a fan placed on, or close to, a desk reduces the area available for paperwork, a computer or other office equipment. Often multiple appliances must be located in the same area, close to a power supply point, and in close proximity to other appliances for ease of connection.

The shape and structure of a fan at a desk not only reduces the working area available to a user but can block natural light (or light from artificial sources) from reaching the desk area. A well lit desk area is desirable for close work and for reading. In addition, a well lit area can reduce eye strain and the related health problems that may result from prolonged periods working in reduced light levels.

In addition, it is undesirable for parts of the appliance to project outwardly, both for safety reasons and because such parts can be difficult to clean.

The present invention seeks to provide an improved fan assembly which obviates disadvantages of the prior art.

In a first aspect the present invention provide a bladeless fan assembly for creating an air current, the fan assembly comprising means for creating an air flow and a nozzle comprising an interior passage for receiving the air flow and a mouth for emitting the air flow, the nozzle extending about an axis to define an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth, the nozzle comprising a surface over which the mouth is arranged to direct the air flow, the surface comprising a diffuser portion tapering away from said axis and a guide portion downstream from the diffuser portion and angled thereto.

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Advantageously, by this arrangement an air current is generated and a cooling effect is created without requiring a bladed fan. The bladeless arrangement leads to lower noise emissions due to the absence of the sound of a fan blade moving through the air, and a reduction in moving parts. The tapered diffuser portion enhances the amplification properties of the fan assembly whilst minimizing noise and frictional losses over the surface. The arrangement and angle of the guide portion result in the shaping or profiling of the divergent air flow exiting the opening. Advantageously, the mean velocity increases as the air flow passes over the guide portion, which increases the cooling effect felt by a user. Advantageously, the arrangement of the guide portion and the diffuser portion directs the air flow towards a user's location whilst maintaining a smooth, even output without the user feeling a 'choppy' flow. The invention provides a fan assembly delivering a suitable cooling effect that is directed and focused as compared to the air flow produced by prior art fans.

In the following description of fan assemblies, and, in particular a fan of the preferred embodiment, the term 'bladeless' is used to describe a fan assembly in which air flow is emitted or projected forward from the fan assembly without the use of moving blades. By this definition a bladeless fan assembly can be considered to have an output area or emission zone absent moving blades from which the air flow is directed towards a user or into a room. The output area of the bladeless fan assembly may be supplied with a primary air flow generated by one of a variety of different sources, such as pumps, generators, motors or other fluid transfer devices, and which may include a rotating device such as a motor rotor and/or a bladed impeller for generating the air flow. The generated primary air flow can pass from the room space or other environment outside the fan assembly through the interior passage to the nozzle, and then back out to the room space through the mouth of the nozzle.

Hence, the description of a fan assembly as bladeless is not intended to extend to the description of the power source and components such as motors that are required for secondary fan functions. Examples of secondary fan functions can include lighting, adjustment and oscillation of the fan assembly.

Preferably, the angle subtended between the diffuser portion and the axis is in the range from 7° to 20°, more preferably around 15°. This arrangement provides for efficient air flow generation. In a preferred embodiment the guide portion extends symmetrically about the axis. By this arrangement the guide portion creates a balanced, or uniform, output surface over which the air flow generated by the fan assembly is emitted. Preferably, the guide portion extends substantially cylindrically about the axis. This creates a region for guiding and directing the airflow output from all around the opening defined by the nozzle of the fan assembly. In addition the cylindrical arrangement creates an assembly with a nozzle that appears tidy and uniform. An uncluttered design is desirable and appeals to a user or customer.

Preferably the nozzle extends by a distance of at least 50 mm in the direction of the axis. Preferably the nozzle extends about the axis by a distance in the range from 300 to 180 mm. This provides options for emission of air over a range of different output areas and opening sizes, such as may be suitable for cooling the upper body and face of a user when working at a desk, for example. Preferably, the guide portion extends in the direction of the axis by a distance in the range from 5 to 60 mm, more preferably around 20 mm. This distance provides a suitable guide structure for directing and concentrating the air flow emitted from the fan assembly and for generating a suitable cooling effect. The preferred dimen-

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sions of the nozzle result in a compact arrangement while generating a suitable amount of air flow from the fan assembly for cooling a user.

The nozzle may comprise a Coanda surface located adjacent the mouth and over which the mouth is arranged to direct the air flow. A Coanda surface is a known type of surface over which fluid flow exiting an output orifice close to the surface exhibits the Coanda effect. The fluid tends to flow over the surface closely, almost 'clinging to' or 'hugging' the surface. The Coanda effect is already a proven, well documented method of entrainment in which a primary air flow is directed over a Coanda surface. A description of the features of a Coanda surface, and the effect of fluid flow over a Coanda surface, can be found in articles such as Reba, Scientific American, Volume 214, June 1966 pages 84 to 92. Through use of a Coanda surface, an increased amount of air from outside the fan assembly is drawn through the opening by the air emitted from the mouth.

In the preferred embodiment an air flow is created through the nozzle of the fan assembly. In the following description this air flow will be referred to as primary air flow. The primary air flow is emitted from the mouth of the nozzle and preferably passes over a Coanda surface. The primary air flow entrains air surrounding the mouth of the nozzle, which acts as an air amplifier to supply both the primary air flow and the entrained air to the user. The entrained air will be referred to here as a secondary air flow. The secondary air flow is drawn from the room space, region or external environment surrounding the mouth of the nozzle and, by displacement, from other regions around the fan assembly, and passes predominantly through the opening defined by the nozzle. The primary air flow directed over the Coanda surface combined with the entrained secondary air flow equates to a total air flow emitted or projected forward from the opening defined by the nozzle. The total air flow is sufficient for the fan assembly to create an air current suitable for cooling. Preferably, the entrainment of air surrounding the mouth of the nozzle is such that the primary air flow is amplified by at least five times, more preferably by at least ten times, while a smooth overall output is maintained.

The air current emitted from the opening defined by the nozzle may have an approximately flat velocity profile across the diameter of the nozzle. Overall the flow rate and profile can be described as plug flow with some regions having a laminar or partial laminar flow. The air current delivered by the fan assembly to the user may have the benefit of being an air flow with low turbulence and with a more linear air flow profile than that provided by other prior art devices. Advantageously, the air flow from the fan can be projected forward from the opening and the area surrounding the mouth of the nozzle with a laminar flow that is experienced by the user as a superior cooling effect to that from a bladed fan. The laminar air flow with low turbulence may travel efficiently out from the point of emission and lose less energy and less velocity to turbulence than the air flow generated by prior art fans. An advantage for a user is that the cooling effect can be felt even at a distance and the overall efficiency of the fan increases. This means that the user can choose to site the fan some distance from a work area or desk and still be able to feel the cooling benefit of the fan.

Preferably the nozzle comprises a loop. The shape of the nozzle is not constrained by the requirement to include space for a bladed fan. In a preferred embodiment the nozzle is annular. By providing an annular nozzle the fan can potentially reach a broad area. In a further preferred embodiment the nozzle is at least partially circular. This arrangement can provide a variety of design options for the fan, increasing the

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choice available to a user or customer. Furthermore, in this arrangement the nozzle can be manufactured as a single piece, reducing the complexity of the fan assembly and thereby reducing manufacturing costs. Alternatively, the nozzle may comprise an inner casing section and an outer casing section which define the interior passage, the mouth and the opening. Each casing section may comprise a plurality of components or a single annular component.

In a preferred arrangement the nozzle comprises at least one wall defining the interior passage and the mouth, and the at least one wall comprises opposing surfaces defining the mouth. Preferably, said at least one wall comprises an inner wall and an outer wall, and wherein the mouth is defined between opposing surfaces of the inner wall and the outer wall. Preferably, the mouth has an outlet, and the spacing between the opposing surfaces at the outlet of the mouth is preferably in the range from 0.5 mm to 5 mm. By this arrangement a nozzle can be provided with the desired flow properties to guide the primary air flow over the surface and provide a relatively uniform, or close to uniform, total air flow reaching the user.

In the preferred fan assembly the means for creating an air flow through the nozzle comprises an impeller driven by a motor. This can provide a fan assembly with efficient air flow generation. The means for creating an air flow preferably comprises a DC brushless motor and a mixed flow impeller. This can avoid frictional losses and carbon debris from the brushes used in a traditional brushed motor. Reducing carbon debris and emissions is advantageous in a clean or pollutant sensitive environment such as a hospital or around those with allergies. While induction motors, which are generally used in bladed fans, also have no brushes, a DC brushless motor can provide a much wider range of operating speeds than an induction motor.

The nozzle may be rotatable or pivotable relative to a base portion, or other portion, of the fan assembly. This enables the nozzle to be directed towards or away from a user as required. The fan assembly may be desk, floor, wall or ceiling mountable. This can increase the portion of a room over which the user experiences cooling.

In a second aspect the present invention provides a nozzle for a bladeless fan assembly for creating an air current, the nozzle comprising an interior passage for receiving an air flow and a mouth for emitting the air flow, the nozzle extending about an axis to define an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth, the nozzle comprising a surface over which the mouth is arranged to direct the air flow, the surface comprising a diffuser portion tapering away from said axis and a guide portion downstream from the diffuser portion and angled thereto.

Features described above in connection with the first aspect of the invention are equally applicable to the second aspect of the invention, and vice versa.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a front view of a fan assembly;

FIG. 2 is a perspective view of a portion of the fan assembly of FIG. 1;

FIG. 3 is a side sectional view through a portion of the fan assembly of FIG. 1 taken at line A-A;

FIG. 4 is an enlarged side sectional detail of a portion of the fan assembly of FIG. 1; and

FIG. 5 is a sectional view of the fan assembly taken along line B-B of FIG. 3 and viewed from direction F of FIG. 3.

FIG. 1 illustrates an example of a fan assembly 100 viewed from the front of the device. The fan assembly 100 comprises

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interior passage 10. The air flow is constricted as it enters the mouth 12 and is further constricted at the outlet 44 of the mouth 12. The constriction creates pressure in the system. The motor 22 creates an air flow through the nozzle 16 having a pressure of at least 400 kPa. The air flow thus created overcomes the pressure created by the constriction and the air flow exits through the outlet 44 as a primary air flow.

The output and emission of the primary air flow creates a low pressure area at the air inlets 24a, 24b with the effect of drawing additional air into the fan assembly 100. The operation of the fan assembly 100 induces high air flow through the nozzle 1 and out through the opening 2. The primary air flow is directed over the Coanda surface 14, the diffuser surface 50 and the guide surface 52. The primary air flow is concentrated or focused towards the user by the guide portion 48 and the angular arrangement of the guide surface 52 to the diffuser surface 50. A secondary air flow is generated by entrainment of air from the external environment, specifically from the region around the outlet 44 and from around the outer edge of the nozzle 1. A portion of the secondary air flow entrained by the primary air flow may also be guided over the diffuser surface 48. This secondary air flow passes through the opening 2, where it combines with the primary air flow to produce a total air flow projected forward from the nozzle 1.

The combination of entrainment and amplification results in a total air flow from the opening 2 of the fan assembly 100 that is greater than the air flow output from a fan assembly without such a Coanda or amplification surface adjacent the emission area.

The distribution and movement of the air flow over the diffuser portion 46 will now be described in terms of the fluid dynamics at the surface.

In general a diffuser functions to slow down the mean speed of a fluid, such as air. This is achieved by moving the air over an area or through a volume of controlled expansion. The divergent passageway or structure forming the space through which the fluid moves must allow the expansion or divergence experienced by the fluid to occur gradually. A harsh or rapid divergence will cause the air flow to be disrupted, causing vortices to form in the region of expansion. In this instance the air flow may become separated from the expansion surface and uneven flow will be generated. Vortices lead to an increase in turbulence, and associated noise, in the air flow which can be undesirable, particularly in a domestic product such as a fan.

In order to achieve a gradual divergence and gradually convert high speed air into lower speed air the diffuser can be geometrically divergent. In the arrangement described above, the structure of the diffuser portion 46 results in an avoidance of turbulence and vortex generation in the fan assembly.

The air flow passing over the diffuser surface 50 and beyond the diffuser portion 46 can tend to continue to diverge as it did through the passageway created by the diffuser portion 46. The influence of the guide portion 48 on the air flow is such that the air flow emitted or output from the fan opening is concentrated or focused towards user or into a room. The net result is an improved cooling effect at the user.

The combination of air flow amplification with the smooth divergence and concentration provided by the diffuser portion 46 and guide portion 48 results in a smooth, less turbulent output than that output from a fan assembly without such a diffuser portion 46 and guide portion 48.

The amplification and laminar type of air flow produced results in a sustained flow of air being directed towards a user from the nozzle 1. In the preferred embodiment the mass flow rate of air projected from the fan assembly 100 is at least 450 l/s, preferably in the range from 600 l/s to 700 l/s. The flow

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rate at a distance of up to 3 nozzle diameters (i.e. around 1000 to 1200 mm) from a user is around 400 to 500 l/s. The total air flow has a velocity of around 3 to 4 m/s (meters per second). Higher velocities are achievable by reducing the angle subtended between the surface and the axis X. A smaller angle results in the total air flow being emitted in a more focused and directed manner. This type of air flow tends to be emitted at a higher velocity but with a reduced mass flow rate. Conversely, greater mass flow can be achieved by increasing the angle between the surface and the axis. In this case the velocity of the emitted air flow is reduced but the mass flow generated increases. Thus the performance of the fan assembly can be altered by altering the angle subtended between the surface and the axis X.

The invention is not limited to the detailed description given above. Variations will be apparent to the person skilled in the art. For example, the fan could be of a different height or diameter. The base and the nozzle of the fan could be of a different depth, width and height. The fan need not be located on a desk, but could be free standing, wall mounted or ceiling mounted. The fan shape could be adapted to suit any kind of situation or location where a cooling flow of air is desired. A portable fan could have a smaller nozzle, say 5 cm in diameter. The means for creating an air flow through the nozzle can be a motor or other air emitting device, such as any air blower or vacuum source that can be used so that the fan assembly can create an air current in a room. Examples include a motor such as an AC induction motor or types of DC brushless motor, but may also comprise any suitable air movement or air transport device such as a pump or other means of providing directed fluid flow to generate and create an air flow. Features of a motor may include a diffuser or a secondary diffuser located downstream of the motor to recover some of the static pressure lost in the motor housing and through the motor.

The outlet of the mouth may be modified. The outlet of the mouth may be widened or narrowed to a variety of spacings to maximize air flow. The air flow emitted by the mouth may pass over a surface, such as Coanda surface, alternatively the airflow may be emitted through the mouth and be projected forward from the fan assembly without passing over an adjacent surface. The Coanda effect may be made to occur over a number of different surfaces, or a number of internal or external designs may be used in combination to achieve the flow and entrainment required. The diffuser portion may be comprised of a variety of diffuser lengths and structures. The guide portion may be a variety of lengths and be arranged at a number of different positions and orientations to as required for different fan requirements and different types of fan performance. The effect of directing or concentrating the effect of the airflow can be achieved in a number of different ways; for example the guide portion may have a shaped surface or be angled away from or towards the center of the nozzle and the axis X.

Other shapes of nozzle are envisaged. For example, a nozzle comprising an oval, or 'racetrack' shape, a single strip or line, or block shape could be used. The fan assembly provides access to the central part of the fan as there are no blades. This means that additional features such as lighting or a clock or LCD display could be provided in the opening defined by the nozzle.

Other features could include a pivotable or tiltable base for ease of movement and adjustment of the position of the nozzle for the user.

The invention claimed is:

1. A bladeless fan assembly for creating an air current, the fan assembly comprising:

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a nozzle mounted on a base housing, and
a device for creating an air flow through the nozzle,
the nozzle comprising,

an interior passage for receiving the air flow from the
base housing, and

a mouth through which the air flow is emitted,
the nozzle extending about an axis to define an opening
through which air from outside the fan assembly is
drawn by the air flow emitted from the mouth,
the nozzle further comprising a surface over which the
mouth is arranged to direct the air flow, the surface
comprising,

a diffuser portion tapering away from said axis,
a guide portion downstream from the diffuser portion and
angled inwardly relative thereto, and
a tapering portion downstream from the guide portion and
angled outwardly relative thereto.

2. The fan assembly of claim 1, wherein the angle sub-
tended between the diffuser portion and the axis is in the
range from 7° to 20°.

3. The fan assembly of claim 1, wherein the guide portion
extends substantially cylindrically about the axis.

4. The fan assembly of claim 1, wherein the nozzle extends
by a distance of at least 5 cm in the direction of the axis.

5. The fan assembly of claim 1, wherein the nozzle extends
about the axis by a distance in the range from 30 cm to 180
cm.

6. The fan assembly of claim 1, wherein the guide portion
extends symmetrically about the axis.

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7. The fan assembly of claim 1, wherein the guide portion
extends in the direction of the axis by a distance in the range
from 5 mm to 60 mm.

8. The fan assembly of claim 1, wherein the nozzle com-
prises a loop.

9. The fan assembly of claim 1, wherein the nozzle is
substantially annular.

10. The fan assembly of claim 1, wherein the nozzle is at
least partially circular.

11. The fan assembly of claim 1, wherein the nozzle com-
prises at least one wall defining the interior passage and the
mouth, and wherein said at least one wall comprises opposing
surfaces defining the mouth.

12. The fan assembly of claim 11, wherein the mouth has
an outlet, and the spacing between the opposing surfaces at
the outlet of the mouth is in the range from 1 mm to 5 mm.

13. The fan assembly of claim 1, wherein the device for
creating an air flow through the nozzle comprises an impeller
driven by a motor.

14. The fan assembly of claim 13, wherein the device for
creating an air flow comprises a DC brushless motor and a
mixed flow impeller.

15. The fan assembly of claim 1, wherein the angle sub-
tended between the diffuser portion and the axis is approxi-
mately 15°.

16. The fan assembly of claim 1, wherein the guide portion
extends in the direction of the axis by a distance of approxi-
mately 20 mm.

* * * * *

EXHIBIT B



US008052379B2

(12) **United States Patent**
Gammack

(10) **Patent No.:** **US 8,052,379 B2**
(45) **Date of Patent:** **Nov. 8, 2011**

(54) **FAN ASSEMBLY**

(75) **Inventor:** **Peter David Gammack**, Malmesbury (GB)

(73) **Assignee:** **Dyson Technology Limited**, Malmesbury (GB)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 21 days.

(21) **Appl. No.:** **12/716,613**

(22) **Filed:** **Mar. 3, 2010**

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F04D 29/62 (2006.01)

(52) **U.S. Cl.** **415/126**

(58) **Field of Classification Search** 415/51,
415/119, 126, 127; 416/9, 13, 16, 117, 118,
416/119

See application file for complete search history.

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Primary Examiner — Nathaniel Wiehe

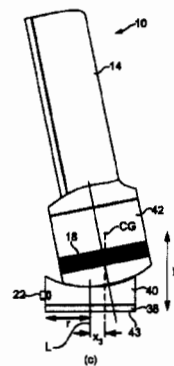
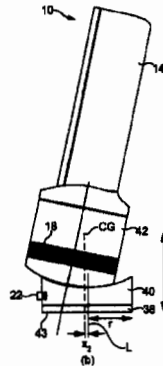
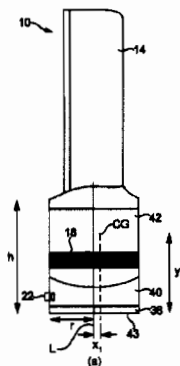
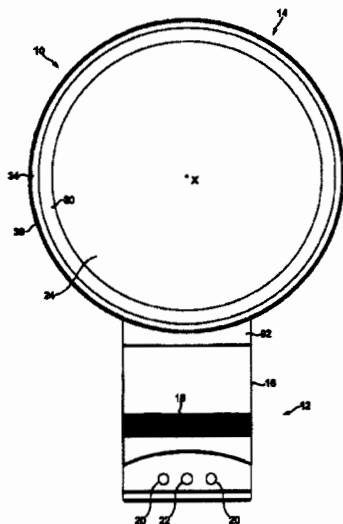
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ABSTRACT

A fan assembly for creating an air current includes an air outlet mounted on a stand. The stand includes a base and a body tiltable relative to the base. The fan assembly has a center of gravity located so that when the base is located on a substantially horizontal support surface, the projection of the center of gravity on the support surface is within the footprint of the base when the body is in a fully tilted position.

16 Claims, 9 Drawing Sheets



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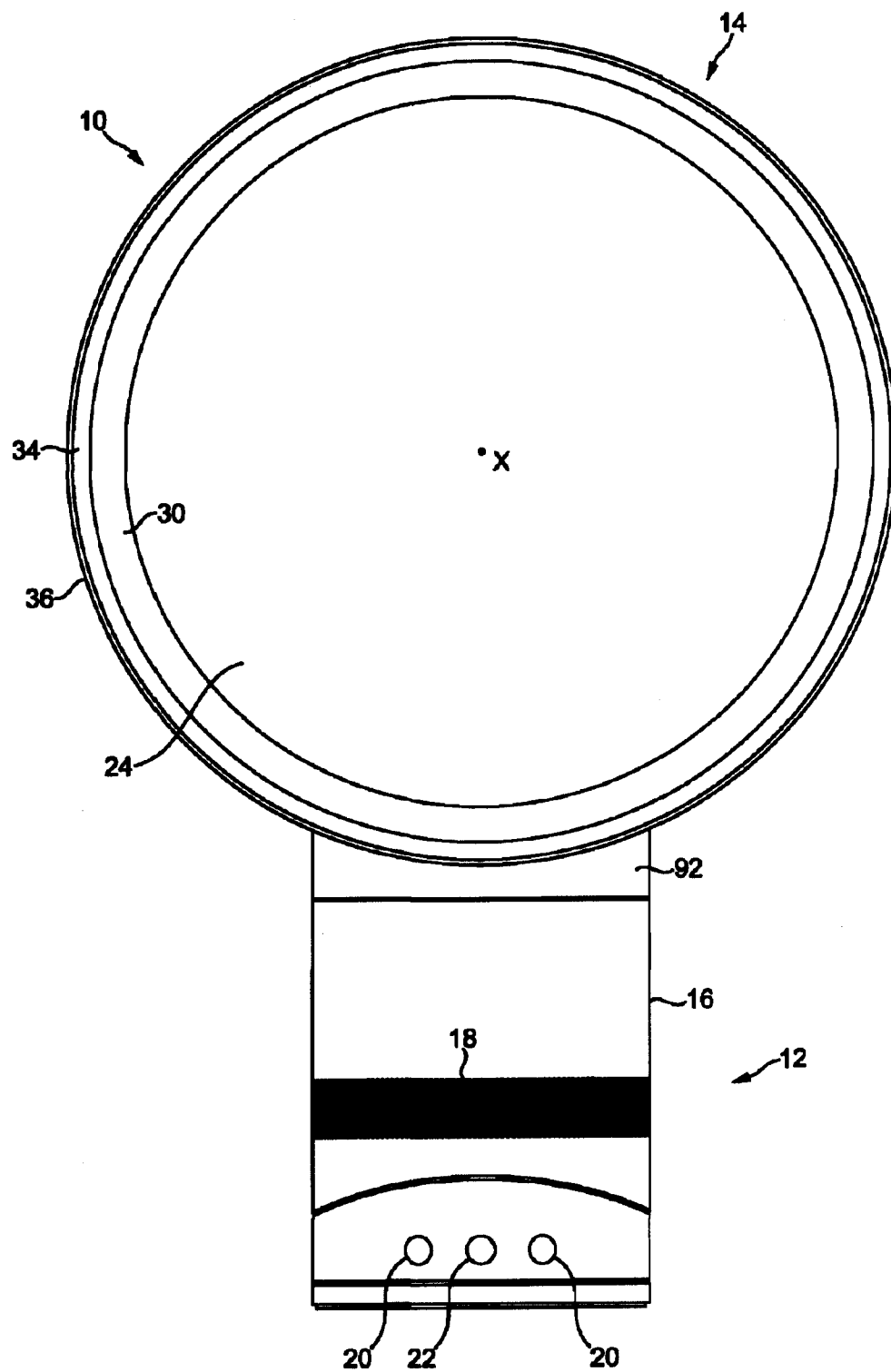


FIG. 1

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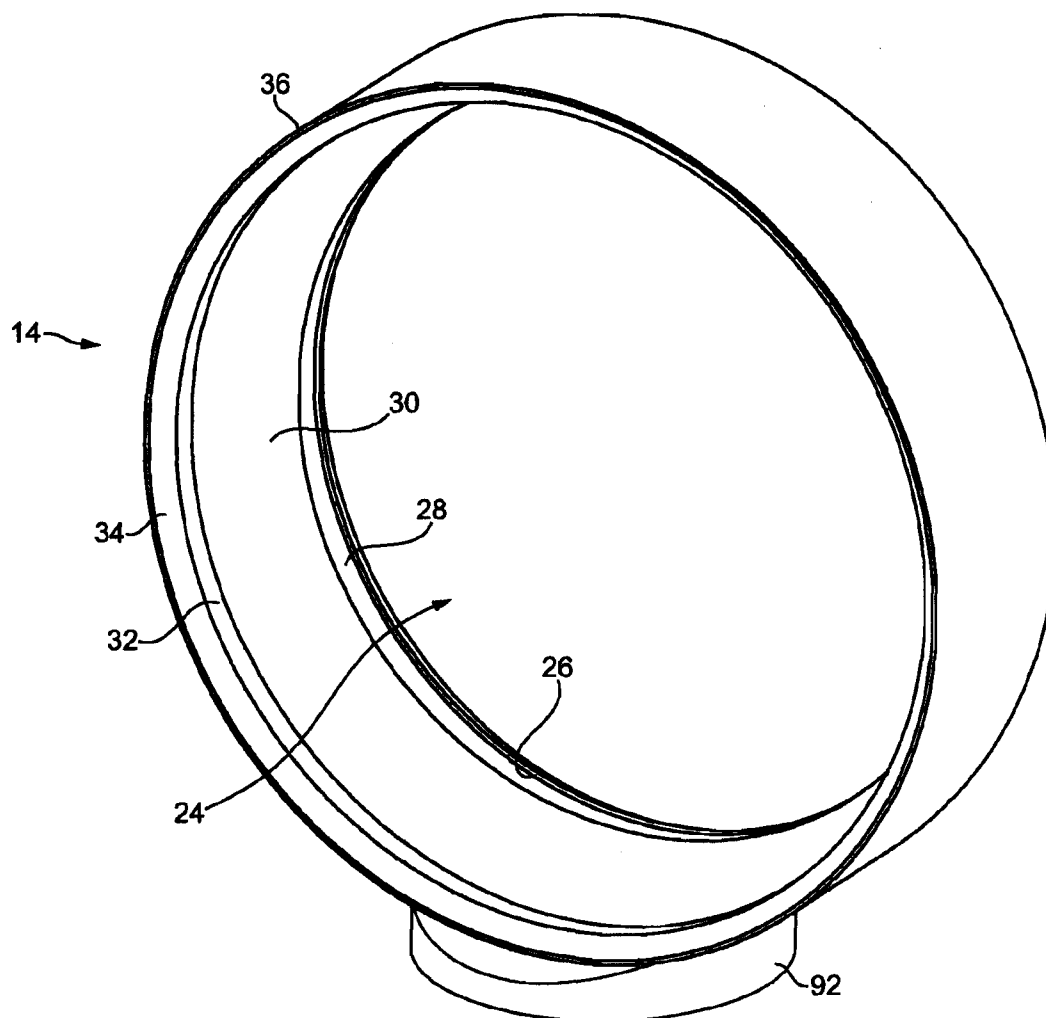


FIG. 2

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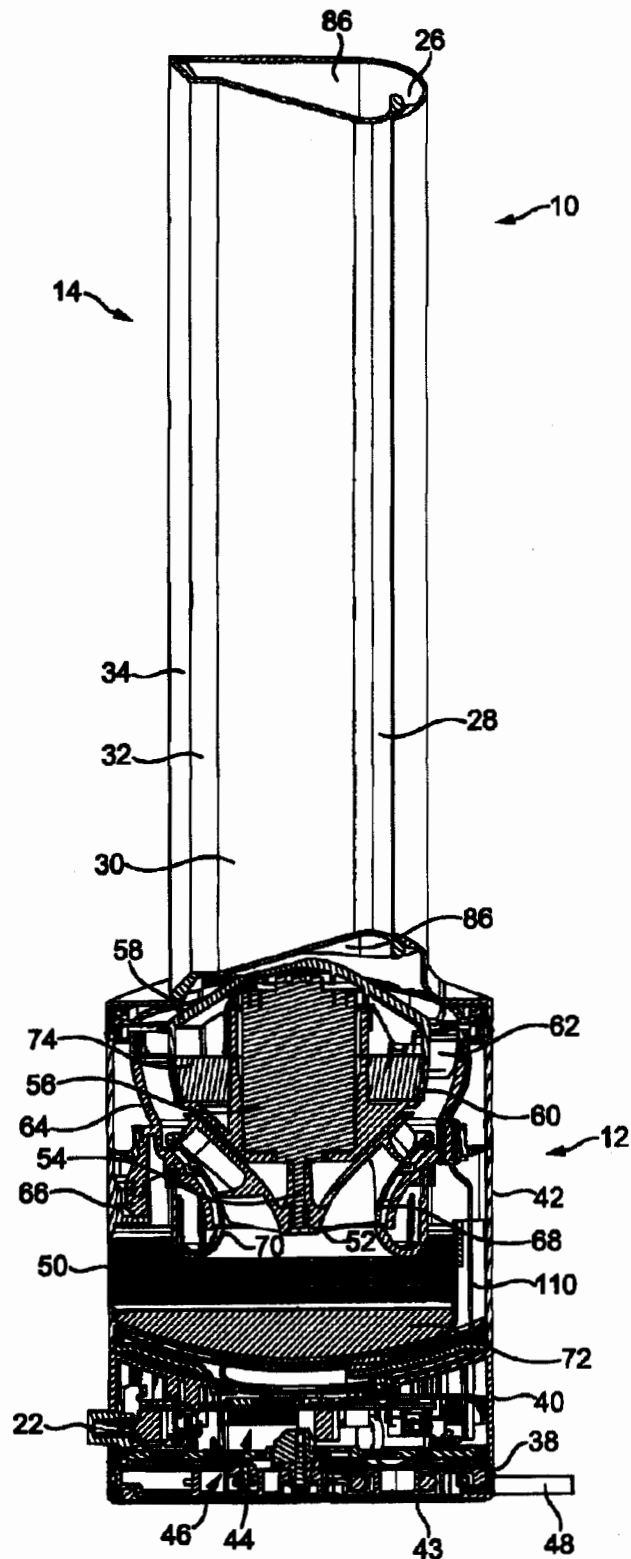


FIG. 3

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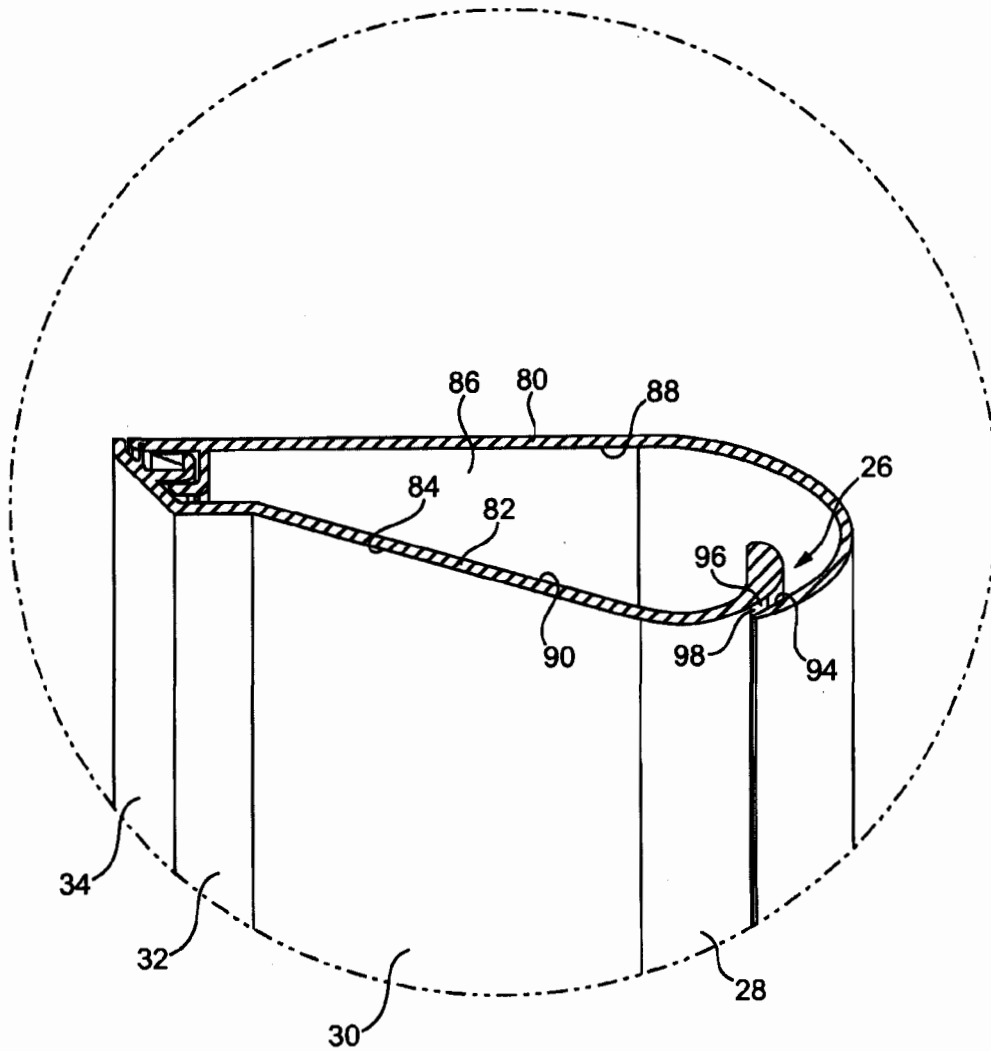


FIG. 4

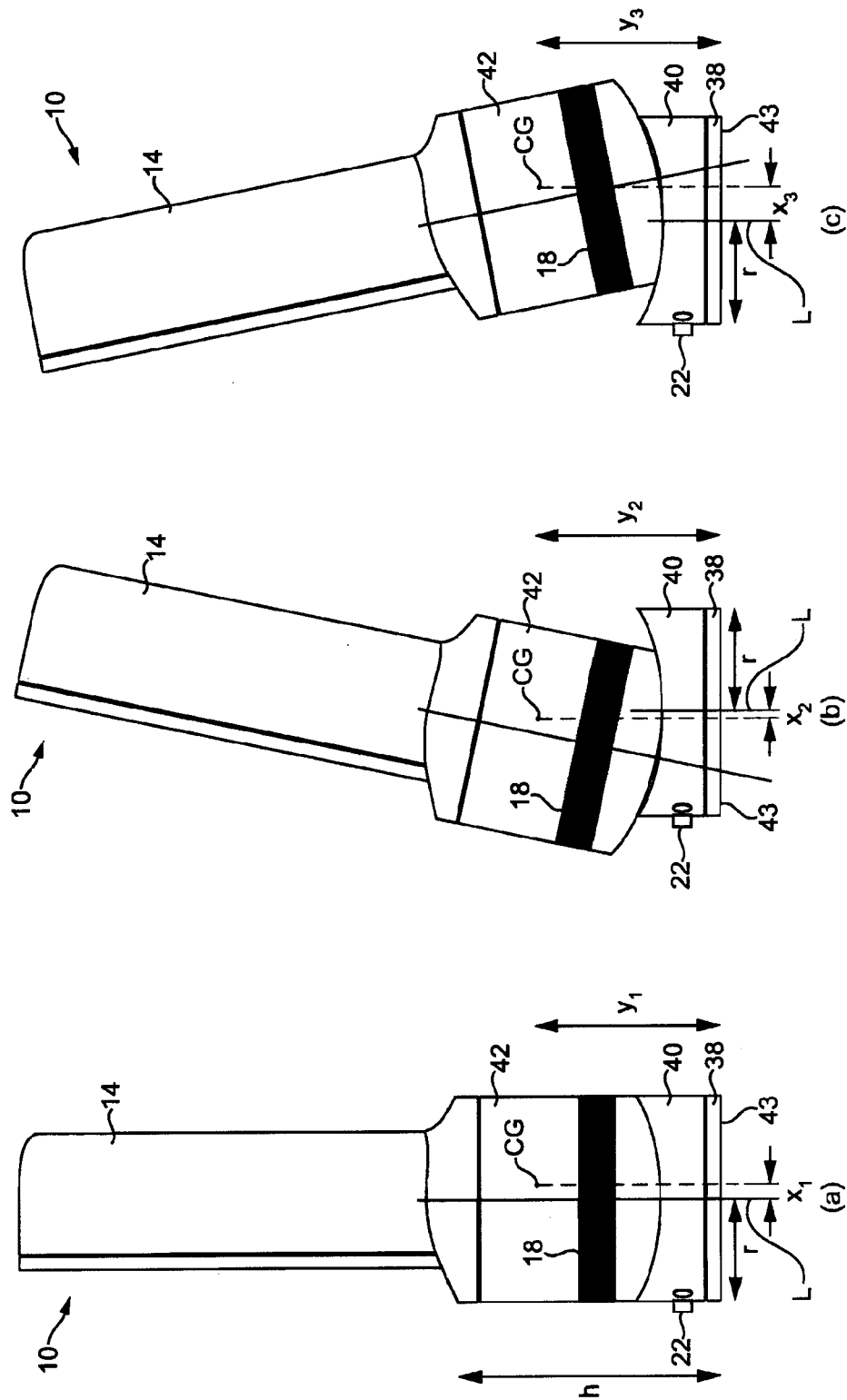


FIG. 5



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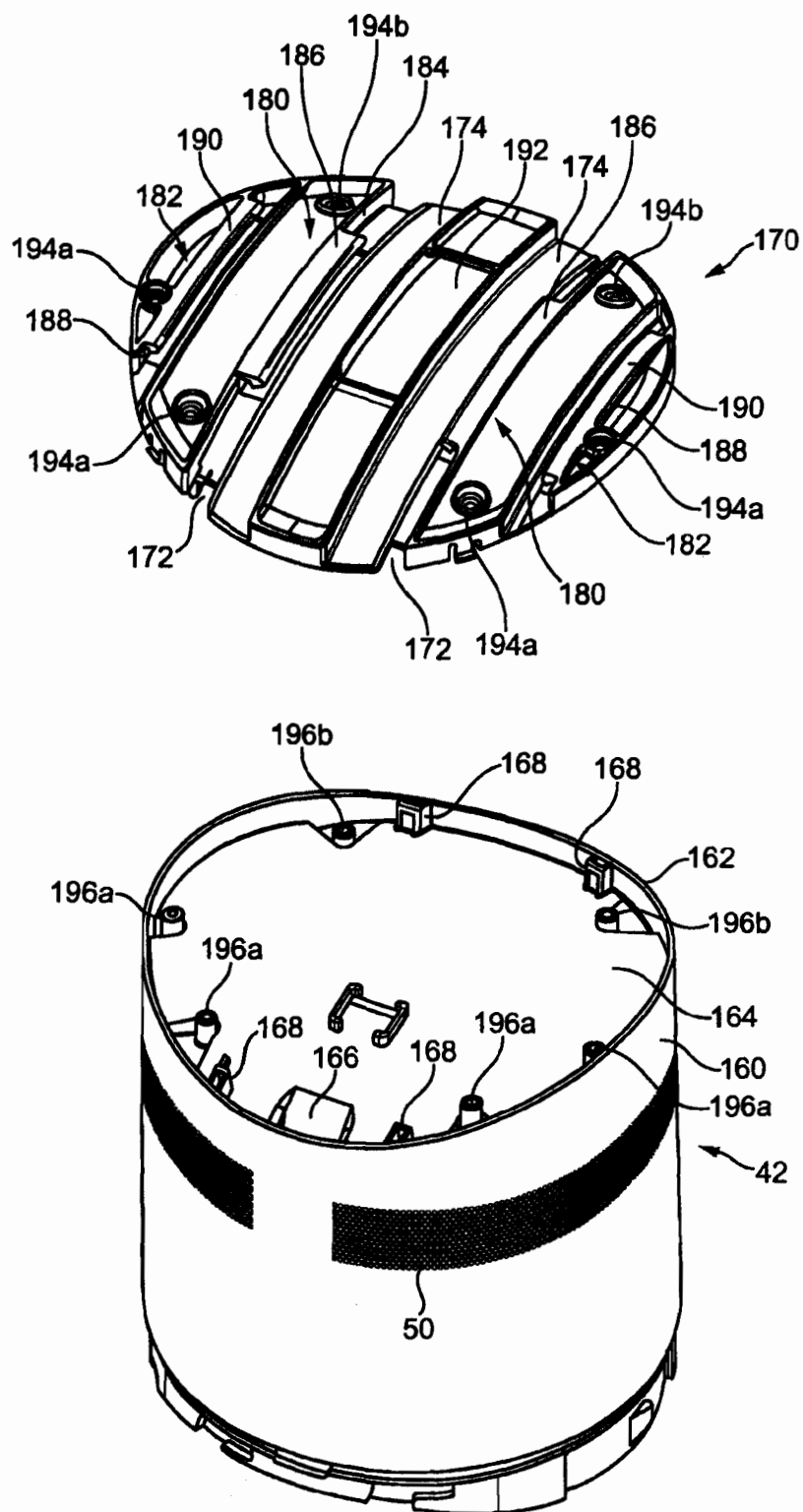


FIG. 8

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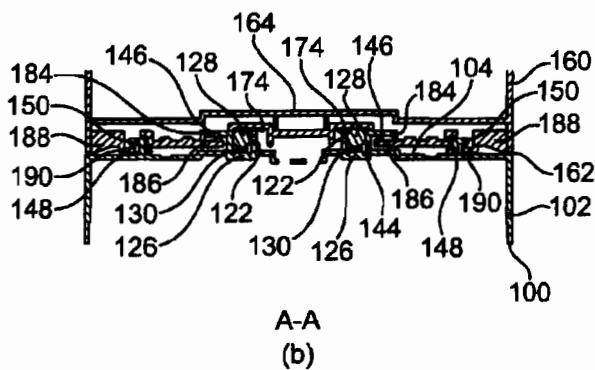
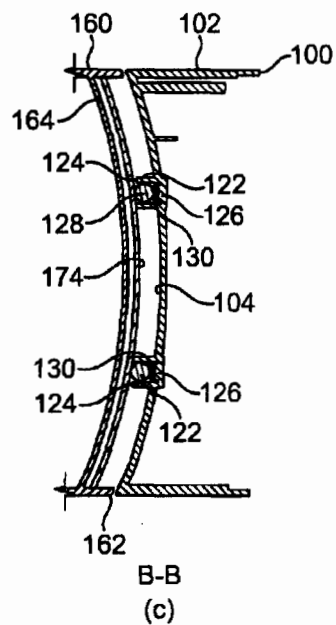
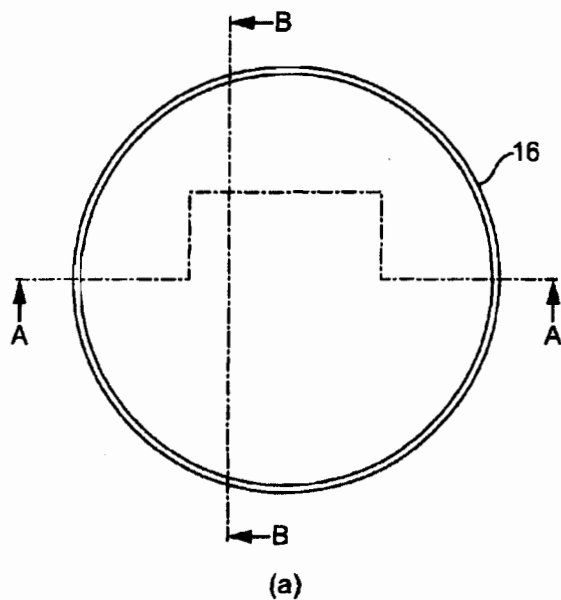


FIG. 9

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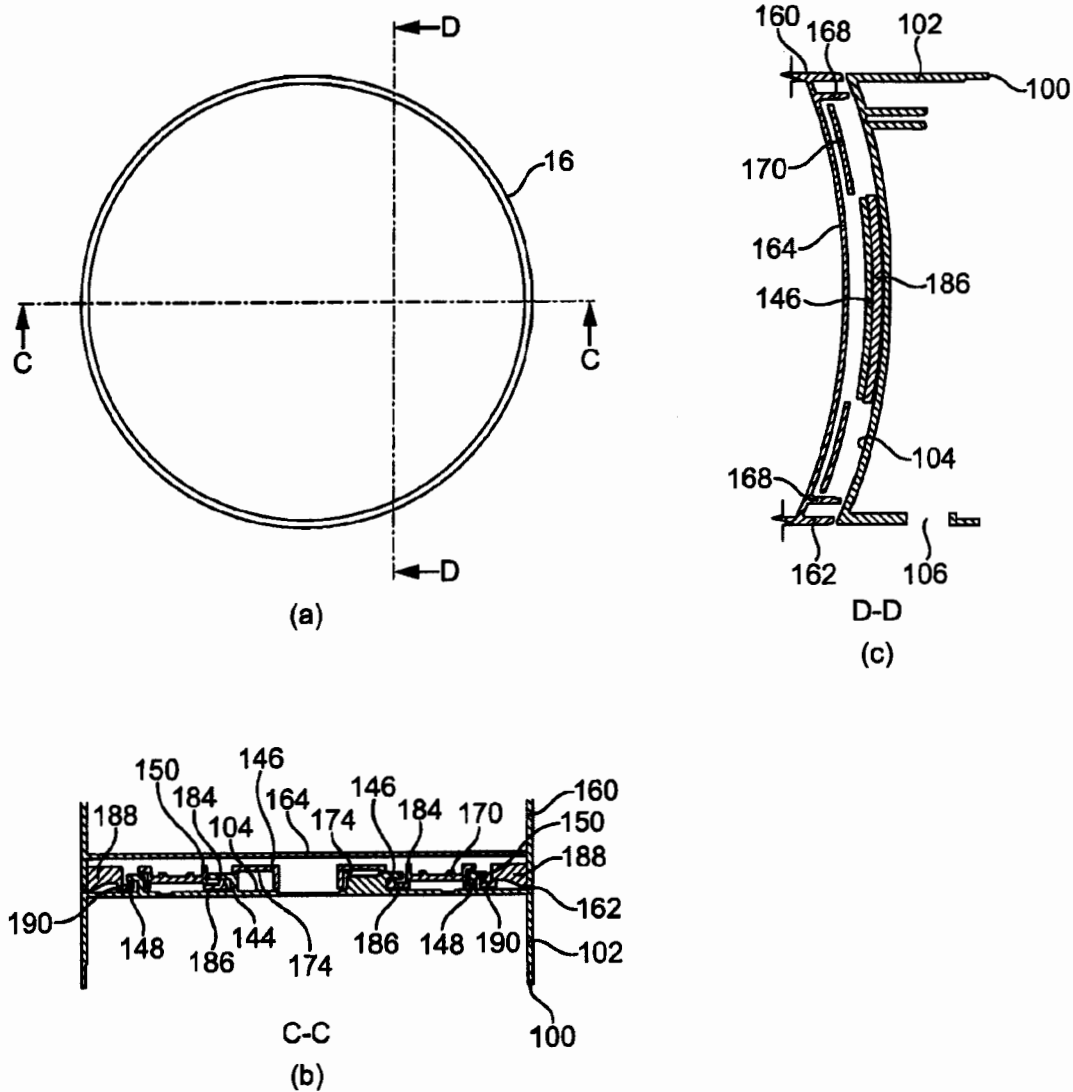


FIG. 10

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FAN ASSEMBLY

REFERENCE TO RELATED APPLICATIONS

This application claims the priority of United Kingdom Application No. 0903674.0, filed 4 Mar. 2009, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a fan assembly. Particularly, but not exclusively, the present invention relates to a domestic fan, such as a desk fan, for creating air circulation and air current in a room, in an office or other domestic environment.

BACKGROUND OF THE INVENTION

A conventional domestic fan typically includes a set of blades or vanes mounted for rotation about an axis, and drive apparatus for rotating the set of blades to generate an air flow. The movement and circulation of the air flow creates a 'wind chill' or breeze and, as a result, the user experiences a cooling effect as heat is dissipated through convection and evaporation.

Such fans are available in a variety of sizes and shapes. For example, a ceiling fan can be at least 1 m in diameter, and is usually mounted in a suspended manner from the ceiling to provide a downward flow of air to cool a room. On the other hand, desk fans are often around 30 cm in diameter, and are usually free standing and portable. Other types of fan can be attached to the floor or mounted on a wall. Fans such as that disclosed in U.S. Pat. No. D 103,476 and U.S. Pat. No. 1,767,060 are suitable for standing on a desk or a table.

A disadvantage of this type of fan is that the air flow produced by the rotating blades is generally not uniform. This is due to variations across the blade surface or across the outward facing surface of the fan. The extent of these variations can vary from product to product and even from one individual fan machine to another. These variations result in the generation of an uneven or 'choppy' air flow which can be felt as a series of pulses of air and which can be uncomfortable for a user. A further disadvantage is that the cooling effect created by the fan diminishes with distance from the user. This means that the fan must be placed in close proximity to the user in order for the user to experience the cooling effect of the fan.

An oscillating mechanism may be employed to rotate the outlet from the fan so that the air flow is swept over a wide area of a room. The oscillating mechanism can lead to some improvement in the quality and uniformity of the air flow felt by a user although the characteristic 'choppy' air flow remains.

Locating fans such as those described above close to a user is not always possible as the bulky shape and structure of the fan mean that the fan occupies a significant amount of the user's work space area.

Some fans, such as that described in U.S. Pat. No. 5,609,473, provide a user with an option to adjust the direction in which air is emitted from the fan. In U.S. Pat. No. 5,609,473, the fan comprises a base and a pair of yokes each upstanding from a respective end of the base. The outer body of the fan houses a motor and a set of rotating blades. The outer body is secured to the yokes so as to be pivotable relative to the base. The fan body may be swung relative to the base from a

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generally vertical, untilted position to an inclined, tilted position. In this way the direction of the air flow emitted from the fan can be altered.

In such fans, a securing mechanism may be employed to fix the position of the body of the fan relative to the base. The securing mechanism may comprise a clamp or manual locking screws which may be difficult to use, particularly for the elderly or for users with impaired dexterity.

In a domestic environment it is desirable for appliances to be as small and compact as possible due to space restrictions. In contrast, fan adjustment mechanisms are often bulky, and are mounted to, and often extend from, the outer surface of the fan assembly.

When such a fan is placed on a desk, the footprint of the adjustment mechanism can undesirably reduce the area available for paperwork, a computer or other office equipment. In addition, it is undesirable for parts of the appliance to project outwardly, both for safety reasons and because such parts can be difficult to clean.

SUMMARY OF THE INVENTION

In a first aspect the present invention provides a fan assembly for creating an air current, the fan assembly comprising a stand and an air outlet mounted on the stand for emitting an air flow, the stand comprising a base and a body tiltably relative to the base from an untilted position to a tilted position, the body comprising a device for creating said air flow, the fan assembly having a centre of gravity located so that when the base is located on a substantially horizontal support surface, the projection of the centre of gravity on the support surface is within the footprint of the base when the body is in a fully tilted position.

The weight of the components of the device for creating said air flow can act to stabilise the body on the base when the body is in a tilted position. The centre of gravity of the fan assembly is preferably located within the body. Preferably the device for creating said air flow comprises an impeller, a motor for rotating the impeller, and preferably also a diffuser located downstream from the impeller. The impeller is preferably a mixed flow impeller. The motor is preferably a DC brushless motor to avoid frictional losses and carbon debris from the brushes used in a traditional brushed motor. Reducing carbon debris and emissions is advantageous in a clean or pollutant sensitive environment such as a hospital or around those with allergies. While induction motors, which are generally used in pedestal fans, also have no brushes, a DC brushless motor can provide a much wider range of operating speeds than an induction motor.

The body preferably comprises at least one air inlet through which air is drawn into the fan assembly by the means for creating said air flow. This can provide a short, compact air flow path that minimises noise and frictional losses.

The projection of the centre of gravity on the support surface may be behind the centre of the base with respect to a forward direction of the fan assembly when the body is in an untilted position.

Each of the base and the body preferably has an outer surface shaped so that adjoining portions of the outer surfaces are substantially flush when the body is in the untilted position. This can provide the stand with a tidy and uniform appearance when in an untilted position. This type of uncluttered appearance is desirable and often appeals to a user or customer. The flush portions also have the benefit of allowing the outer surfaces of the base and the body to be quickly and easily wiped clean. The outer surfaces of the base and the

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body are preferably substantially cylindrical. In the preferred embodiment the stand is substantially cylindrical.

Preferably the base has a substantially circular footprint having a radius r , and a longitudinal axis passing centrally therethrough. Preferably the centre of gravity of the fan assembly is spaced by a radial distance of no more than 0.8 r , more preferably no more than 0.6 r and preferably no more than 0.4 r , from the longitudinal axis when the body is in a fully tilted position. This can provide the fan assembly with increased stability.

Preferably, the base comprising a plurality of rolling elements for supporting the body, the body comprising a plurality of curved races for receiving the rolling elements and within which the rolling elements move as the body is moved from an untilted position to a tilted position. The curved races of the body are preferably convex in shape. Preferably the base comprises a plurality of support members each comprising a respective one of the rolling elements. The support surfaces preferably protrude from a curved, preferably concave, surface of the base of the stand.

The stand preferably comprises interlocking means or members for retaining the body on the base. The interlocking means are preferably enclosed by the outer surfaces of the base and the body when the body is in the untilted position so that the stand retains its tidy and uniform appearance.

The stand preferably comprises biasing means for urging the interlocking means together to resist movement of the body from the tilted position. The base preferably comprises a plurality of support members for supporting the body, and which are preferably also enclosed by the outer surfaces of the base and the body when the body is in the untilted position. Each support member preferably comprises a rolling element for supporting the body, the body comprising a plurality of curved races for receiving the rolling elements and within which the rolling elements move as the body is moved from an untilted position to a tilted position.

The interlocking means preferably comprises a first plurality of locking members located on the base, and a second plurality of locking members located on the body and which are retained by the first plurality of locking members. Each of the locking members is preferably substantially L-shaped. The interlocking members preferably comprise interlocking flanges, which are preferably curved. The curvature of the flanges of the interlocking members of the base is preferably substantially the same as the curvature of the flanges of the interlocking members of the body. This can maximise the frictional forces generated between the interlocking flanges which act against the movement of the body from the tilted position.

The stand preferably comprises means for inhibiting the movement of the body relative to the base beyond a fully tilted position. The movement inhibiting means preferably comprises a stop member depending from the body for engaging part of the base when the body is in a fully tilted position. In the preferred embodiment the stop member is arranged to engage part of the interlocking means, preferably a flange of an interlocking member of the base, to inhibit movement of the body relative to the base beyond the fully tilted position.

The base preferably comprises a controller for controlling the fan assembly. For safety reasons and ease of use, it can be advantageous to locate control elements away from the tiltable body so that the control functions, such as, for example, oscillation, lighting or activation of a speed setting, are not activated during a tilt operation.

The fan assembly is preferably in the form of a bladeless fan assembly. Through use of a bladeless fan assembly an air current can be generated without the use of a bladed fan.

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Without the use of a bladed fan to project the air current from the fan assembly, a relatively uniform air current can be generated and guided into a room or towards a user. The air current can travel efficiently out from the outlet, losing little energy and velocity to turbulence.

The term 'bladeless' is used to describe a fan assembly in which air flow is emitted or projected forward from the fan assembly without the use of moving blades. Consequently, a bladeless fan assembly can be considered to have an output area, or emission zone, absent moving blades from which the air flow is directed towards a user or into a room. The output area of the bladeless fan assembly may be supplied with a primary air flow generated by one of a variety of different sources, such as pumps, generators, motors or other fluid transfer devices, and which may include a rotating device such as a motor rotor and/or a bladed impeller for generating the air flow. The generated primary air flow can pass from the room space or other environment outside the fan assembly into the fan assembly, and then back out to the room space through the outlet.

Hence, the description of a fan assembly as bladeless is not intended to extend to the description of the power source and components such as motors that are required for secondary fan functions. Examples of secondary fan functions can include lighting, adjustment and oscillation of the fan assembly.

The air outlet preferably comprises a nozzle mounted on the stand, the nozzle comprising a mouth for emitting the air flow, the nozzle extending about an opening through which air from outside the nozzle is drawn by the air flow emitted from the mouth. Preferably, the nozzle surrounds the opening. The nozzle may be an annular nozzle which preferably has a height in the range from 200 to 600 mm, more preferably in the range from 250 to 500 mm.

Preferably, the mouth of the nozzle extends about the opening, and is preferably annular. The nozzle preferably comprises an inner casing section and an outer casing section which define the mouth of the nozzle. Each section is preferably formed from a respective annular member, but each section may be provided by a plurality of members connected together or otherwise assembled to form that section. The outer casing section is preferably shaped so as to partially overlap the inner casing section. This can enable an outlet of the mouth to be defined between overlapping portions of the external surface of the inner casing section and the internal surface of the outer casing section of the nozzle. The outlet is preferably in the form of a slot, preferably having a width in the range from 0.5 to 5 mm, more preferably in the range from 0.5 to 1.5 mm. The nozzle may comprise a plurality of spacers for urging apart the overlapping portions of the inner casing section and the outer casing section of the nozzle. This can assist in maintaining a substantially uniform outlet width about the opening. The spacers are preferably evenly spaced along the outlet.

The nozzle preferably comprises an interior passage for receiving the air flow from the stand. The interior passage is preferably annular, and is preferably shaped to divide the air flow into two air streams which flow in opposite directions around the opening. The interior passage is preferably also defined by the inner casing section and the outer casing section of the nozzle.

The fan assembly preferably comprises means for oscillating the nozzle so that the air current is swept over an arc, preferably in the range from 60 to 120°. For example, the base of the stand may comprise means for oscillating an upper base member, to which the body is connected, relative to a lower base member.

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The maximum air flow of the air current generated by the fan assembly is preferably in the range from 300 to 800 liters per second, more preferably in the range from 500 to 800 liters per second.

The nozzle may comprise a surface, preferably a Coanda surface, located adjacent the mouth and over which the mouth is arranged to direct the air flow emitted therefrom. Preferably, the external surface of the inner casing section of the nozzle is shaped to define the Coanda surface. The Coanda surface preferably extends about the opening. A Coanda surface is a known type of surface over which fluid flow exiting an output orifice close to the surface exhibits the Coanda effect. The fluid tends to flow over the surface closely, almost 'clinging to' or 'hugging' the surface. The Coanda effect is already a proven, well documented method of entrainment in which a primary air flow is directed over a Coanda surface. A description of the features of a Coanda surface, and the effect of fluid flow over a Coanda surface, can be found in articles such as Reba, Scientific American, Volume 214, June 1966 pages 84 to 92. Through use of a Coanda surface, an increased amount of air from outside the fan assembly is drawn through the opening by the air emitted from the mouth.

Preferably, an air flow enters the nozzle of the fan assembly from the stand. In the following description this air flow will be referred to as primary air flow. The primary air flow is emitted from the mouth of the nozzle and preferably passes over a Coanda surface. The primary air flow entrains air surrounding the mouth of the nozzle, which acts as an air amplifier to supply both the primary air flow and the entrained air to the user. The entrained air will be referred to here as a secondary air flow. The secondary air flow is drawn from the room space, region or external environment surrounding the mouth of the nozzle and, by displacement, from other regions around the fan assembly, and passes predominantly through the opening defined by the nozzle. The primary air flow directed over the Coanda surface combined with the entrained secondary air flow equates to a total air flow emitted or projected forward from the opening defined by the nozzle. Preferably, the entrainment of air surrounding the mouth of the nozzle is such that the primary air flow is amplified by at least five times, more preferably by at least ten times, while a smooth overall output is maintained.

Preferably, the nozzle comprises a diffuser surface located downstream of the Coanda surface. The external surface of the inner casing section of the nozzle is preferably shaped to define the diffuser surface.

In a second aspect the present invention provides a fan assembly for creating an air current, the fan assembly comprising an air outlet mounted on a stand comprising a base and a body tiltable relative to the base from an untilted position to a tilted position, the air outlet comprising a nozzle mounted on the stand, the nozzle comprising a mouth for emitting the air flow, the nozzle extending about an opening through which air from outside the nozzle is drawn by the air flow emitted from the mouth, the fan assembly having a centre of gravity located so that when the base is located on a substantially horizontal support surface, the projection of the centre of gravity on the support surface is within the footprint of the base when the body is in a fully tilted position.

Features described above in relation to the first aspect of the invention are equally applicable to the second aspect of the invention, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

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FIG. 1 is a front view of a fan assembly;

FIG. 2 is a perspective view of the nozzle of the fan assembly of FIG. 1;

FIG. 3 is a sectional view through the fan assembly of FIG. 1;

FIG. 4 is an enlarged view of part of FIG. 3;

FIG. 5(a) is a side view of the fan assembly of FIG. 1 showing the fan assembly in an untilted position;

FIG. 5(b) is a side view of the fan assembly of FIG. 1 showing the fan assembly in a first tilted position;

FIG. 5(c) is a side view of the fan assembly of FIG. 1 showing the fan assembly in a second tilted position;

FIG. 6 is a top perspective view of the upper base member of the fan assembly of FIG. 1;

FIG. 7 is a rear perspective view of the main body of the fan assembly of FIG. 1;

FIG. 8 is an exploded view of the main body of FIG. 7;

FIG. 9(a) illustrates the paths of two sectional views through the stand when the fan assembly is in an untilted position;

FIG. 9(b) is a sectional view along line A-A of FIG. 9(a);

FIG. 9(c) is a sectional view along line B-B of FIG. 9(a);

FIG. 10(a) illustrates the paths of two further sectional views through the stand when the fan assembly is in an untilted position;

FIG. 10(b) is a sectional view along line C-C of FIG. 10(a); and

FIG. 10(c) is a sectional view along line D-D of FIG. 10(a);

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a front view of a fan assembly 10. The fan assembly 10 is preferably in the form of a bladeless fan assembly comprising a stand 12 and a nozzle 14 mounted on and supported by the stand 12. The stand 12 comprises a substantially cylindrical outer casing 16 having a plurality of air inlets 18 in the form of apertures located in the outer casing 16 and through which a primary air flow is drawn into the stand 12 from the external environment. The stand 12 further comprises a plurality of user-operable buttons 20 and a user-operable dial 22 for controlling the operation of the fan assembly 10. The stand 12 preferably has a height in the range from 200 to 300 mm, and the outer casing 16 preferably has an external diameter in the range from 100 to 200 mm. In this example, the stand 12 has a height h of around 190 mm, and an external diameter $2r$ of around 145 mm.

With reference also to FIG. 2, the nozzle 14 has an annular shape and defines a central opening 24. The nozzle 14 has a height in the range from 200 to 400 mm. The nozzle 14 comprises a mouth 26 located towards the rear of the fan assembly 10 for emitting air from the fan assembly 10 and through the opening 24. The mouth 26 extends at least partially about the opening 24. The inner periphery of the nozzle 14 comprises a Coanda surface 28 located adjacent the mouth 26 and over which the mouth 26 directs the air emitted from the fan assembly 10, a diffuser surface 30 located downstream of the Coanda surface 28 and a guide surface 32 located downstream of the diffuser surface 30. The diffuser surface 30 is arranged to taper away from the central axis X of the opening 24 in such a way so as to assist the flow of air emitted from the fan assembly 10. The angle subtended between the diffuser surface 30 and the central axis X of the opening 24 is in the range from 5 to 25°, and in this example is around 15°. The guide surface 32 is arranged at an angle to the diffuser surface 30 to further assist the efficient delivery of a cooling air flow from the fan assembly 10. The guide surface 32 is preferably arranged substantially parallel to the central axis X

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of the opening 24 to present a substantially flat and substantially smooth face to the air flow emitted from the mouth 26. A visually appealing tapered surface 34 is located downstream from the guide surface 32, terminating at a tip surface 36 lying substantially perpendicular to the central axis X of the opening 24. The angle subtended between the tapered surface 34 and the central axis X of the opening 24 is preferably around 45°. The overall depth of the nozzle 24 in a direction extending along the central axis X of the opening 24 is in the range from 100 to 150 mm, and in this example is around 110 mm.

FIG. 3 illustrates a sectional view through the fan assembly 10. The stand 12 comprises a base formed from a lower base member 38 and an upper base member 40 mounted on the lower base member 38, and a main body 42 mounted on the base. The lower base member 38 has a substantially flat, substantially circular bottom surface 43 for engaging a support surface upon which the fan assembly 10 is located. Due to the cylindrical nature of the base, the footprint of the base is the same size as the bottom surface 43 of the lower base member 38, and so the footprint of the base has a radius r . The upper base member 40 houses a controller 44 for controlling the operation of the fan assembly 10 in response to depression of the user operable buttons 20 shown in FIGS. 1 and 2, and/or manipulation of the user operable dial 22. The upper base member 40 may also house an oscillating mechanism 46 for oscillating the upper base member 40 and the main body 42 relative to the lower base member 38. The range of each oscillation cycle of the main body 42 is preferably between 60° and 120°, and in this example is around 90°. In this example, the oscillating mechanism 46 is arranged to perform around 3 to 5 oscillation cycles per minute. A mains power cable 48 extends through an aperture formed in the lower base member 38 for supplying electrical power to the fan assembly 10.

The main body 42 of the stand 12 has an open upper end to which the nozzle 14 is connected, for example by a snap-fit connection. The main body 42 comprises a cylindrical grille 50 in which an array of apertures is formed to provide the air inlets 18 of the stand 12. The main body 42 houses an impeller 52 for drawing the primary air flow through the apertures of the grille 50 and into the stand 12. Preferably, the impeller 52 is in the form of a mixed flow impeller. The impeller 52 is connected to a rotary shaft 54 extending outwardly from a motor 56. In this example, the motor 56 is a DC brushless motor having a speed which is variable by the controller 44 in response to user manipulation of the dial 22. The maximum speed of the motor 56 is preferably in the range from 5,000 to 10,000 rpm. The motor 56 is housed within a motor bucket comprising an upper portion 58 connected to a lower portion 60. One of the upper portion 58 and the lower portion 60 of the motor bucket comprises a diffuser 62 in the form of a stationary disc having spiral blades, and which is located downstream from the impeller 52.

The motor bucket is located within, and mounted on, an impeller housing 64. The impeller housing 64 is, in turn, mounted on a plurality of angularly spaced supports 66, in this example three supports, located within the main body 42 of the stand 12. A generally frusto-conical shroud 68 is located within the impeller housing 64. The shroud 68 is shaped so that the outer edges of the impeller 52 are in close proximity to, but do not contact, the inner surface of the shroud 68. A substantially annular inlet member 70 is connected to the bottom of the impeller housing 64 for guiding the primary air flow into the impeller housing 64. Preferably, the stand 12 further comprises silencing foam for reducing noise emissions from the stand 12. In this example, the main

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body 42 of the stand 12 comprises a disc-shaped foam member 72 located towards the base of the main body 42, and a substantially annular foam member 74 located within the motor bucket.

FIG. 4 illustrates a sectional view through the nozzle 14. The nozzle 14 comprises an annular outer casing section 80 connected to and extending about an annular inner casing section 82. Each of these sections may be formed from a plurality of connected parts, but in this embodiment each of the outer casing section 80 and the inner casing section 82 is formed from a respective, single moulded part. The inner casing section 82 defines the central opening 24 of the nozzle 14, and has an external peripheral surface 84 which is shaped to define the Coanda surface 28, diffuser surface 30, guide surface 32 and tapered surface 34.

The outer casing section 80 and the inner casing section 82 together define an annular interior passage 86 of the nozzle 14. Thus, the interior passage 86 extends about the opening 24. The interior passage 86 is bounded by the internal peripheral surface 88 of the outer casing section 80 and the internal peripheral surface 90 of the inner casing section 82. The outer casing section 80 comprises a base 92 which is connected to, and over, the open upper end of the main body 42 of the stand 12, for example by a snap-fit connection. The base 92 of the outer casing section 80 comprises an aperture through which the primary air flow enters the interior passage 86 of the nozzle 14 from the open upper end of the main body 42 of the stand 12.

The mouth 26 of the nozzle 14 is located towards the rear of the fan assembly 10. The mouth 26 is defined by overlapping, or facing, portions 94, 96 of the internal peripheral surface 88 of the outer casing section 80 and the external peripheral surface 84 of the inner casing section 82, respectively. In this example, the mouth 26 is substantially annular and, as illustrated in FIG. 4, has a substantially U-shaped cross-section when sectioned along a line passing diametrically through the nozzle 14. In this example, the overlapping portions 94, 96 of the internal peripheral surface 88 of the outer casing section 80 and the external peripheral surface 84 of the inner casing section 82 are shaped so that the mouth 26 tapers towards an outlet 98 arranged to direct the primary flow over the Coanda surface 28. The outlet 98 is in the form of an annular slot, preferably having a relatively constant width in the range from 0.5 to 5 mm. In this example the outlet 98 has a width of around 1.1 mm. Spacers may be spaced about the mouth 26 for urging apart the overlapping portions 94, 96 of the internal peripheral surface 88 of the outer casing section 80 and the external peripheral surface 84 of the inner casing section 82 to maintain the width of the outlet 98 at the desired level. These spacers may be integral with either the internal peripheral surface 88 of the outer casing section 80 or the external peripheral surface 84 of the inner casing section 82.

Turning now to FIGS. 5(a), 5(b) and 5(c), the main body 42 is moveable relative to the base of the stand 12 between a first fully tilted position, as illustrated in FIG. 5(b), and a second fully tilted position, as illustrated in FIG. 5(c). This axis X is preferably inclined by an angle of around 10° as the main body 42 is moved from an untilted position, as illustrated in FIG. 5(a) to one of the two fully tilted positions. The outer surfaces of the main body 42 and the upper base member 40 are shaped so that adjoining portions of these outer surfaces of the main body 42 and the base are substantially flush when the main body 42 is in the untilted position.

The centre of gravity of the fan assembly is identified at CG in FIGS. 5(a), 5(b) and 5(c). The centre of gravity CG is located within the main body 42 of the stand 12. When the lower base member 38 of the stand 12 is located on a hori-

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zontal support surface, the projection of the centre of gravity CG on the support surface is within the footprint of the base, irrespective of the position of the main body 42 between the first and second fully tilted positions, so that the fan assembly 10 is in a stable configuration irrespective of the position of the main body 42.

With reference to FIG. 5(a), when the main body 42 is in the untitled position the projection of the centre of gravity CG on the support surface lies behind the centre of the base with respect to a forward direction of the fan assembly, which is from right to left as viewed in FIGS. 5(a), 5(b) and 5(c). In this example, the radial distance x_1 between the longitudinal axis L of the base and the centre of gravity CG is around $0.15 r$, where r is the radius of the bottom surface 43 of the lower base member 38, and the distance y_1 along the longitudinal axis L between the bottom surface 43 and the centre of gravity is around $0.7 h$, where h is the height of the stand 12. When the main body 42 is in the first fully tilted position illustrated in FIG. 5(b) the projection of the centre of gravity CG on the support surface lies slightly in front of the centre of the base. In this example, the radial distance x_2 between the longitudinal axis L of the base and the centre of gravity CG is around $0.05 r$, while the distance y_2 along the longitudinal axis L between the bottom surface 43 and the centre of gravity remains around $0.7 h$. When the main body 42 is in the second fully tilted position illustrated in FIG. 5(c), the projection of the centre of gravity CG on the support surface lies behind the centre of the base. In this example, the radial distance x_3 between the longitudinal axis L of the base and the centre of gravity CG is around $0.35 r$, while the distance y_3 along the longitudinal axis L between the bottom surface 43 and the centre of gravity remains around $0.7 h$. The difference between y_2 and y_3 is preferably no more than 5 mm, more preferably no more than 2 mm.

With reference to FIG. 6, the upper base member 40 comprises an annular lower surface 100 which is mounted on the lower base member 38, a substantially cylindrical side wall 102 and a curved upper surface 104. The side wall 102 comprises a plurality of apertures 106. The user-operable dial 22 protrudes through one of the apertures 106 whereas the user-operable buttons 20 are accessible through the other apertures 106. The curved upper surface 104 of the upper base member 40 is concave in shape, and may be described as generally saddle-shaped. An aperture 108 is formed in the upper surface 104 of the upper base member 40 for receiving an electrical cable 110 (shown in FIG. 3) extending from the motor 56.

The upper base member 40 further comprises four support members 120 for supporting the main body 42 on the upper base member 40. The support members 120 project upwardly from the upper surface 104 of the upper base member 40, and are arranged such that they are substantially equidistant from each other, and substantially equidistant from the centre of the upper surface 104. A first pair of the support members 120 is located along the line B-B indicated in FIG. 9(a), and a second pair of the support members 120 is parallel with the first pair of support members 120. With reference also to FIGS. 9(b) and 9(c), each support member 120 comprises a cylindrical outer wall 122, an open upper end 124 and a closed lower end 126. The outer wall 122 of the support member 120 surrounds a rolling element 128 in the form of a ball bearing. The rolling element 128 preferably has a radius which is slightly smaller than the radius of the cylindrical outer wall 122 so that the rolling element 128 is retained by and moveable within the support member 120. The rolling element 128 is urged away from the upper surface 104 of the upper base member 40 by a resilient element 130 located between the closed lower end 126 of the support member 120 and the

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rolling element 128 so that part of the rolling element 128 protrudes beyond the open upper end 124 of the support member 120. In this embodiment, the resilient member 130 is in the form of a coiled spring.

Returning to FIG. 6, the upper base member 40 also comprises a plurality of rails for retaining the main body 42 on the upper base member 40. The rails also serve to guide the movement of the main body 42 relative to the upper base member 40 so that there is substantially no twisting or rotation of the main body 42 relative to the upper base member 40 as it is moved from or to a tilted position. Each of the rails extends in a direction substantially parallel to the axis X. For example, one of the rails lies along line D-D indicated in FIG. 10(a). In this embodiment, the plurality of rails comprises a pair of relatively long, inner rails 140 located between a pair of relatively short, outer rails 142. With reference also to FIGS. 9(b) and 10(b), each of the inner rails 140 has a cross-section in the form of an inverted L-shape, and comprises a wall 144 which extends between a respective pair of the support members 120, and which is connected to, and upstanding from, the upper surface 104 of the upper base member 40. Each of the inner rails 140 further comprises a curved flange 146 which extends along the length of the wall 144, and which protrudes orthogonally from the top of the wall 144 towards the adjacent outer guide rail 142. Each of the outer rails 142 also has a cross-section in the form of an inverted L-shape, and comprises a wall 148 which is connected to, and upstanding from, the upper surface 52 of the upper base member 40 and a curved flange 150 which extends along the length of the wall 148, and which protrudes orthogonally from the top of the wall 148 away from the adjacent inner guide rail 140.

With reference now to FIGS. 7 and 8, the main body 42 comprises a substantially cylindrical side wall 160, an annular lower end 162 and a curved base 164 which is spaced from lower end 162 of the main body 42 to define a recess. The grille 50 is preferably integral with the side wall 160. The side wall 160 of the main body 42 has substantially the same external diameter as the side wall 102 of the upper base member 40. The base 164 is convex in shape, and may be described generally as having an inverted saddle-shape. An aperture 166 is formed in the base 164 for allowing the cable 110 to extend from the base 164 of the main body 42. Two pairs of stop members 168 extend upwardly (as illustrated in FIG. 8) from the periphery of base 164. Each pair of stop members 168 is located along a line extending in a direction substantially parallel to the axis X. For example, one of the pairs of stop members 168 is located along line D-D illustrated in FIG. 10(a).

A convex tilt plate 170 is connected to the base 164 of the main body 42. The tilt plate 170 is located within the recess of the main body 42, and has a curvature which is substantially the same as that of the base 164 of the main body 42. Each of the stop members 168 protrudes through a respective one of a plurality of apertures 172 located about the periphery of the tilt plate 170. The tilt plate 170 is shaped to define a pair of convex races 174 for engaging the rolling elements 128 of the upper base member 40. Each race 174 extends in a direction substantially parallel to the axis X, and is arranged to receive the rolling elements 128 of a respective pair of the support members 120, as illustrated in FIG. 9(c).

The tilt plate 170 also comprises a plurality of runners, each of which is arranged to be located at least partially beneath a respective rail of the upper base member 40 and thus co-operate with that rail to retain the main body 42 on the upper base member 40 and to guide the movement of the main body 42 relative to the upper base member 40. Thus, each of

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the runners extends in a direction substantially parallel to the axis X. For example, one of the runners lies along line D-D indicated in FIG. 10(a). In this embodiment, the plurality of runners comprises a pair of relatively long, inner runners 180 located between a pair of relatively short, outer runners 182. With reference also to FIGS. 9(b) and 10(b), each of the inner runners 180 has a cross-section in the form of an inverted L-shape, and comprises a substantially vertical wall 184 and a curved flange 186 which protrudes orthogonally and inwardly from part of the top of the wall 184. The curvature of the curved flange 186 of each inner runner 180 is substantially the same as the curvature of the curved flange 146 of each inner rail 140. Each of the outer runners 182 also has a cross-section in the form of an inverted L-shape, and comprises a substantially vertical wall 188 and a curved flange 190 which extends along the length of the wall 188, and which protrudes orthogonally and inwardly from the top of the wall 188. Again, the curvature of the curved flange 190 of each outer runner 182 is substantially the same as the curvature of the curved flange 150 of each outer rail 142. The tilt plate 170 further comprises an aperture 192 for receiving the cable 110.

To connect the main body 42 to the upper base member 40, the tilt plate 170 is inverted from the orientation illustrated in FIGS. 7 and 8, and the races 174 of the tilt plate located directly behind and in line with the support members 120 of the upper base member 40. The cable 110 extending through the aperture 166 of the main body 42 may be threaded through the apertures 108, 192 in the tilt plate 170 and the upper base member 40 respectively for subsequent connection to the controller 44, as illustrated in FIG. 3. The tilt plate 170 is then slid over the upper base member 40 so that the rolling elements 128 engage the races 174, as illustrated in FIGS. 9(b) and 9(c), the curved flange 190 of each outer runner 182 is located beneath the curved flange 150 of a respective outer rail 142, as illustrated in FIGS. 9(b) and 10(b), and the curved flange 186 of each inner runner 180 is located beneath the curved flange 146 of a respective inner rail 140, as illustrated in FIGS. 9(b), 10(b) and 10(c).

With the tilt plate 170 positioned centrally on the upper base member 40, the main body 42 is lowered on to the tilt plate 170 so that the stop members 168 are located within the apertures 172 of the tilt plate 170, and the tilt plate 170 is housed within the recess of the main body 42. The upper base member 40 and the main body 42 are then inverted, and the base member 40 displaced along the direction of the axis X to reveal a first plurality of apertures 194a located on the tilt plate 170. Each of these apertures 194a is aligned with a tubular protrusion 196a on the base 164 of the main body 42. A self-tapping screw is screwed into each of the apertures 194a to enter the underlying protrusion 196a, thereby partially connecting the tilt plate 170 to the main body 42. The upper base member 40 is then displaced in the reverse direction to reveal a second plurality of apertures 194b located on the tilt plate 170. Each of these apertures 194b is also aligned with a tubular protrusion 196b on the base 164 of the main body 42. A self-tapping screw is screwed into each of the apertures 194b to enter the underlying protrusion 196b to complete the connection of the tilt plate 170 to the main body 42.

When the main body 42 is attached to the base and the bottom surface 43 of the lower base member 38 positioned on a support surface, the main body 42 is supported by the rolling elements 128 of the support members 120. The resilient elements 130 of the support members 120 urge the rolling elements 128 away from the closed lower ends 126 of the support members 120 by a distance which is sufficient to inhibit scraping of the upper surfaces of the upper base member 40

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when the main body 42 is tilted. For example, as illustrated in each of FIGS. 9(b), 9(c), 10(b) and 10(c) the lower end 162 of the main body 42 is urged away from the upper surface 104 of the upper base member 40 to prevent contact therebetween when the main body 42 is tilted. Furthermore, the action of the resilient elements 130 urges the concave upper surfaces of the curved flanges 186, 190 of the runners against the convex lower surfaces of the curved flanges 146, 150 of the rails.

To tilt the main body 42 relative to the base, the user slides the main body 42 in a direction parallel to the axis X to move the main body 42 towards one of the fully tilted positions illustrated in FIGS. 5(b) and 5(c), causing the rolling elements 128 to move along the races 174. Once the main body 42 is in the desired position, the user releases the main body 42, which is retained in the desired position by frictional forces generated through the contact between the concave upper surfaces of the curved flanges 186, 190 of the runners and the convex lower surfaces of the curved flanges 146, 150 of the rails acting to resist the movement under gravity of the main body 42 towards the untilted position illustrated in FIG. 5(a). The fully tilted positions of the main body 42 are defined by the abutment of one of each pair of stop members 168 with a respective inner rail 140.

To operate the fan assembly 10 the user depresses an appropriate one of the buttons 20 on the stand 12, in response to which the controller 44 activates the motor 56 to rotate the impeller 52. The rotation of the impeller 52 causes a primary air flow to be drawn into the stand 12 through the air inlets 18. Depending on the speed of the motor 56, the primary air flow may be between 20 and 30 liters per second. The primary air flow passes sequentially through the impeller housing 64 and the open upper end of the main body 42 to enter the interior passage 86 of the nozzle 14. Within the nozzle 14, the primary air flow is divided into two air streams which pass in opposite directions around the central opening 24 of the nozzle 14. As the air streams pass through the interior passage 86, air enters the mouth 26 of the nozzle 14. The air flow into the mouth 26 is preferably substantially even about the opening 24 of the nozzle 14. Within each section of the mouth 26, the flow direction of the portion of the air stream is substantially reversed. The portion of the air stream is constricted by the tapering section of the mouth 26 and emitted through the outlet 98.

The primary air flow emitted from the mouth 26 is directed over the Coanda surface 28 of the nozzle 14, causing a secondary air flow to be generated by the entrainment of air from the external environment, specifically from the region around the outlet 98 of the mouth 26 and from around the rear of the nozzle 14. This secondary air flow passes through the central opening 24 of the nozzle 14, where it combines with the primary air flow to produce a total air flow, or air current, projected forward from the nozzle 14. Depending on the speed of the motor 56, the mass flow rate of the air current projected forward from the fan assembly 10 may be up to 400 liters per second, preferably up to 600 liters per second, and the maximum speed of the air current may be in the range from 2.5 to 4 m/s.

The even distribution of the primary air flow along the mouth 26 of the nozzle 14 ensures that the air flow passes evenly over the diffuser surface 30. The diffuser surface 30 causes the mean speed of the air flow to be reduced by moving the air flow through a region of controlled expansion. The relatively shallow angle of the diffuser surface 30 to the central axis X of the opening 24 allows the expansion of the air flow to occur gradually. A harsh or rapid divergence would otherwise cause the air flow to become disrupted, generating vortices in the expansion region. Such vortices can lead to an

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increase in turbulence and associated noise in the air flow which can be undesirable, particularly in a domestic product such as a fan. The air flow projected forwards beyond the diffuser surface 30 can tend to continue to diverge. The presence of the guide surface 32 extending substantially parallel to the central axis X of the opening 30 further converges the air flow. As a result, the air flow can travel efficiently out from the nozzle 14, enabling the air flow can be experienced rapidly at a distance of several metres from the fan assembly 10.

The invention is not limited to the detailed description given above. Variations will be apparent to the person skilled in the art. For example, the stand 12 may be used in a variety of appliances other than a fan assembly. The movement of the main body 42 relative to the base may be motorised, and actuated by the user through depression of one of the buttons 20.

The invention claimed is:

1. A fan assembly for creating an air current, the fan assembly comprising an air outlet mounted on a stand comprising a base and a body tiltable relative to the base from an untilted position to a tilted position, the fan assembly having a center of gravity located so that when the base is located on a substantially horizontal support surface, a projection of the center of gravity on the support surface is within the footprint of the base when the body is in a fully tilted position, wherein the body comprises a device for creating an air flow through the fan assembly and the air outlet comprises a nozzle mounted on the body of the stand, the nozzle comprising a mouth for emitting the air flow, the nozzle extending about an opening through which air from outside the nozzle is drawn by the air flow emitted from the mouth, and wherein the nozzle comprises a Coanda surface located adjacent the mouth and over which the mouth is arranged to direct the air flow emitted therefrom.

2. The fan assembly of claim 1, wherein the center of gravity of the fan assembly is located within the body.

3. The fan assembly of claim 1, wherein the device for creating the air flow comprises an impeller and a motor for driving the impeller.

4. The fan assembly of claim 1, wherein the projection of the center of gravity on the support surface is behind the center of the base with respect to a forward direction of the fan assembly when the body is in an untilted position.

5. The fan assembly of claim 1, comprising interlocking members for retaining the body on the base.

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6. The fan assembly of claim 5, comprising a biasing member for urging the interlocking members together to resist movement of the body from the tilted position.

7. The fan assembly of claim 1, wherein the stand comprises at least one stop member for inhibiting the movement of the body relative to the base beyond a fully tilted position.

8. The fan assembly of claim 7, wherein the stop member extends from the body for engaging part of the base when the body is in a fully tilted position.

9. The fan assembly of claim 1, wherein the base of the stand comprises a controller for controlling the fan assembly.

10. The fan assembly of claim 1, wherein the device for creating the air flow further comprises a diffuser located downstream from the impeller.

11. The fan assembly of claim 1, wherein the body comprises at least one air inlet through which the air is drawn into the fan assembly by the device for creating the air flow.

12. A fan assembly for creating an air current, the fan assembly comprising an air outlet mounted on a stand comprising a base and a body tiltable relative to the base from an untilted position to a tilted position, the fan assembly having a center of gravity located so that when the base is located on a substantially horizontal support surface, a projection of the center of gravity on the support surface is within the footprint of the base when the body is in a fully tilted position, wherein the body comprises a device for creating an air flow through the fan assembly and the air outlet comprises a nozzle mounted on the body of the stand, the nozzle comprising a mouth for emitting the air flow, the nozzle extending about an opening through which air from outside the nozzle is drawn by the air flow emitted from the mouth, and wherein the base comprises a plurality of rolling elements for supporting the body, and the body comprises a plurality of curved races for receiving the rolling elements and within which the rolling elements move as the body is moved from an untilted position to a tilted position.

13. The fan assembly of claim 12, wherein the curved races of the body are convex in shape.

14. The fan assembly of claim 12, wherein the base further comprises a plurality of support members each comprising a respective one of the rolling elements.

15. The fan assembly as claimed in claim 14, wherein the support members protrude from a curved surface of the base.

16. The fan assembly of claim 15, wherein the curved surface of the base is concave in shape.

* * * * *

EXHIBIT C



US008092166B2

(12) **United States Patent**
Nicolas et al.

(10) **Patent No.:** **US 8,092,166 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

(54) **FAN**

(75) **Inventors:** **Frederic Nicolas**, Malmesbury (GB);
Kevin John Simmonds, Malmesbury (GB)

(73) **Assignee:** **Dyson Technology Limited**,
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(22) **Filed:** **Nov. 20, 2009**

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(52) **U.S. Cl.** **415/209.2**; 415/209.4; 415/211.2;
415/220; 415/223; 415/225; 415/226; 415/914;
239/419.5; 239/590; 239/590.5; 239/597;
239/598; 239/DIG. 7

(58) **Field of Classification Search** 415/185,
415/191, 208.1, 208.2, 210.1, 211.2, 220,
415/222, 223, 225, 226, 209.2, 209.3, 914,
415/189, 190, 209.4; 239/419.5, 590, 590.5,
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See application file for complete search history.

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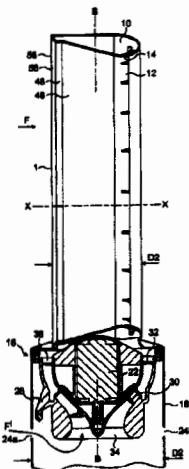
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(57) **ABSTRACT**

A fan assembly for creating an air current is described. The fan assembly includes a nozzle mounted on a base housing a device for creating an air flow through the nozzle. The nozzle includes an interior passage for receiving the air flow from the base, a mouth through which the air flow is emitted, the mouth being defined by facing surfaces of the nozzle, and spacers for spacing apart the facing surfaces of the nozzle. The nozzle extends substantially orthogonally about an axis to define an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth. The fan provides an arrangement producing an air current and a flow of cooling air created without requiring a bladed fan. The spacers can provide for a reliable, reproducible nozzle of the fan assembly and performance of the fan assembly.

26 Claims, 6 Drawing Sheets



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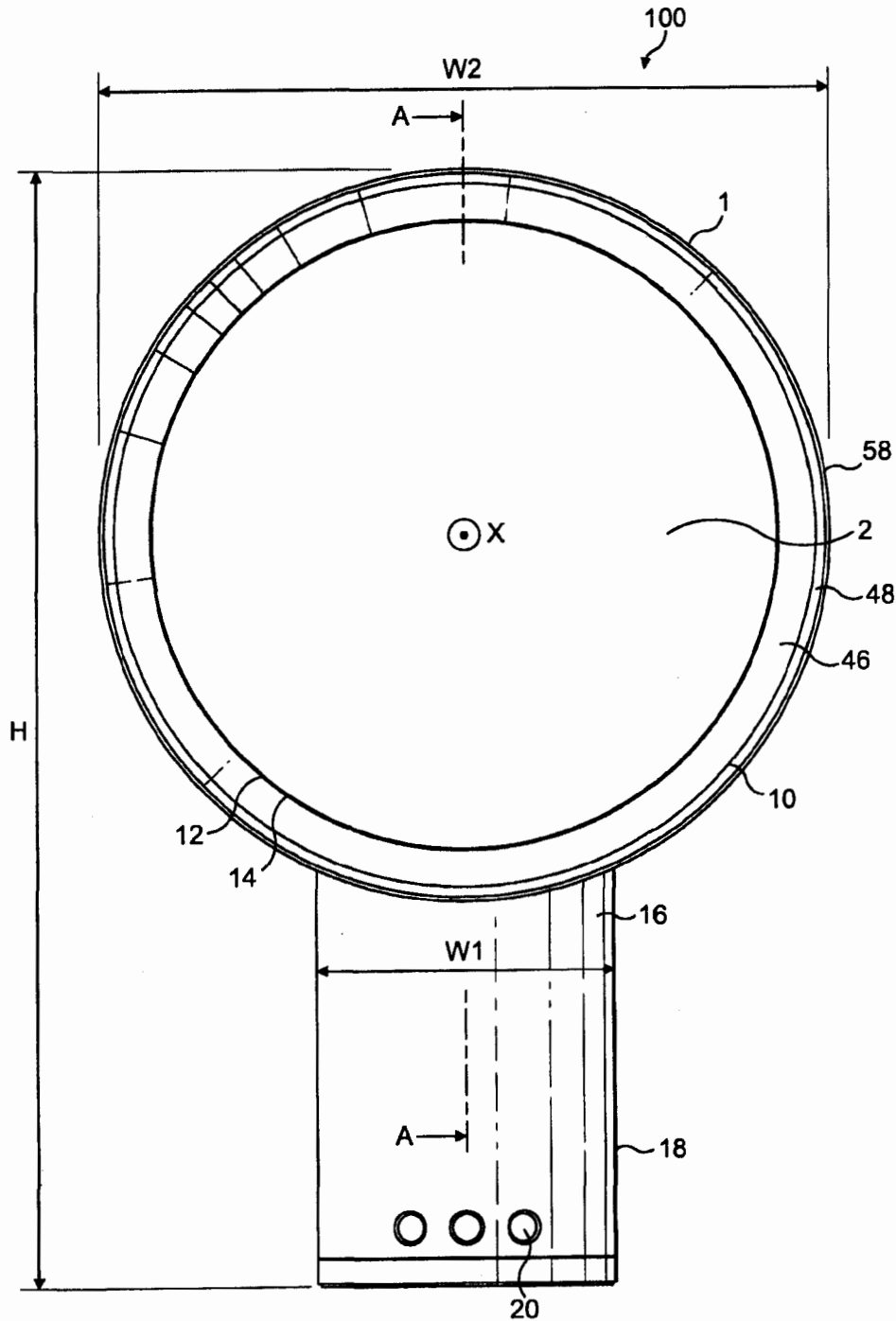


FIG. 1

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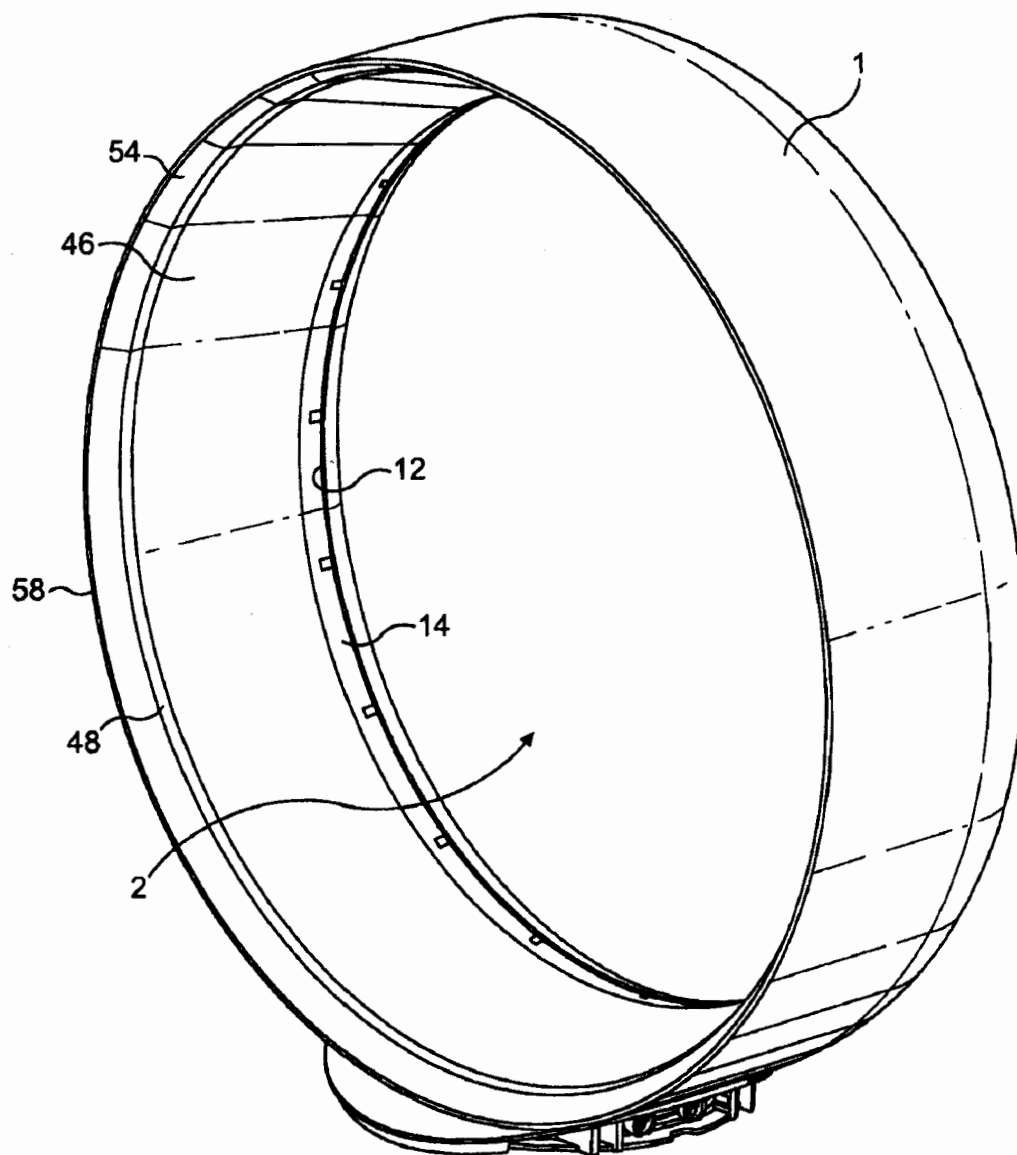


FIG. 2

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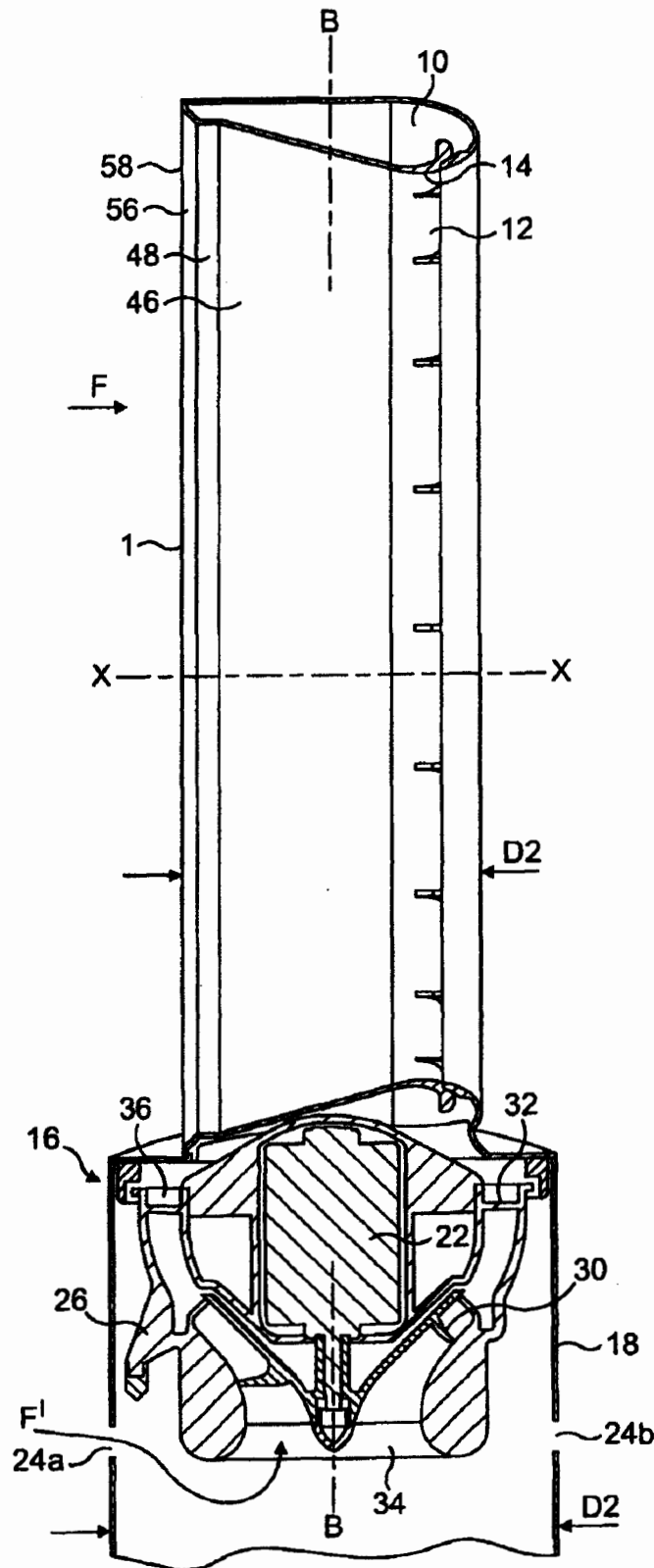


FIG. 3



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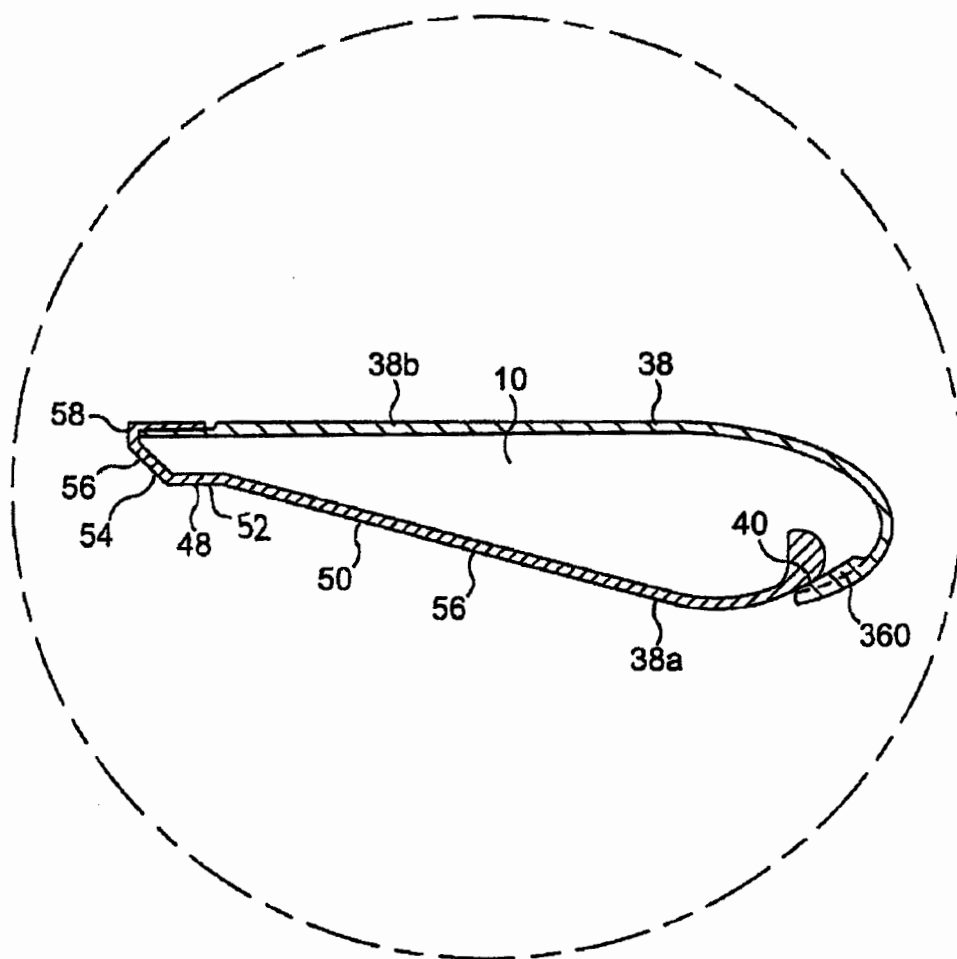


FIG. 5

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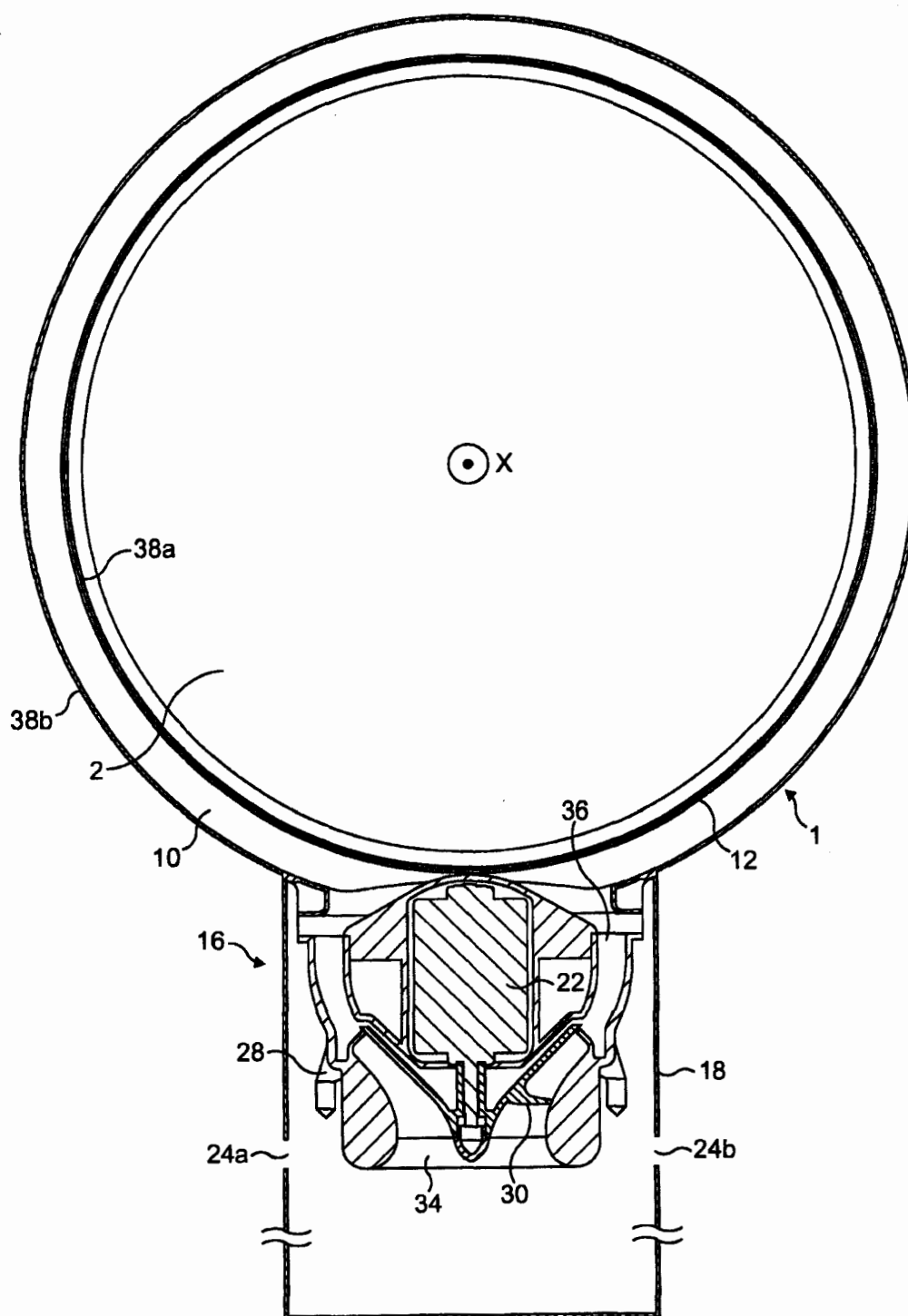


FIG. 6

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1 FAN

REFERENCE TO RELATED APPLICATIONS

This application claims the priority of United Kingdom Application No. 0822612.8, filed Dec. 11, 2008, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a fan appliance. Particularly, but not exclusively, the present invention relates to a domestic fan, such as a desk fan, for creating air circulation and air current in a room, in an office or other domestic environment.

BACKGROUND OF THE INVENTION

A number of types of domestic fan are known. It is common for a conventional fan to include a single set of blades or vanes mounted for rotation about an axis, and driving apparatus mounted about the axis for rotating the set of blades. Domestic fans are available in a variety of sizes and diameters, for example, a ceiling fan can be at least 1 m in diameter and is usually mounted in a suspended manner from the ceiling and positioned to provide a downward flow of air and cooling throughout a room.

Desk fans, on the other hand, are often around 30 cm in diameter and are usually free standing and portable. In standard desk fan arrangements the single set of blades is positioned close to the user and the rotation of the fan blades provides a forward flow of air current in a room or into a part of a room, and towards the user. Other types of fan can be attached to the floor or mounted on a wall. The movement and circulation of the air creates a so called 'wind chill' or breeze and, as a result, the user experiences a cooling effect as heat is dissipated through convection and evaporation. Fans such as that disclosed in U.S. D Pat. No. 103,476 and U.S. Pat. No. 1,767,060 are suitable for standing on a desk or a table. U.S. Pat. No. 1,767,060 describes a desk fan with an oscillating function that aims to provide an air circulation equivalent to two or more prior art fans.

A disadvantage of this type of arrangement is that the forward flow of air current produced by the rotating blades of the fan is not felt uniformly by the user. This is due to variations across the blade surface or across the outward facing surface of the fan. Uneven or 'choppy' air flow can be felt as a series of pulses or blasts of air and can be noisy. Variations across the blade surface, or across other fan surfaces, can vary from product to product and may even vary from one individual fan machine to another.

In a domestic environment it is desirable for appliances to be as small and compact as possible due to space restrictions. It is undesirable for parts to project from the appliance, or for the user to be able to touch any moving parts of the fan, such as the blades. Some arrangements have safety features such as a cage or shroud around the blades to protect a user from injuring himself on the moving parts of the fan. U.S. D Pat. No. 103,476 shows a type of cage around the blades however, caged blade parts can be difficult to clean.

Other types of fan or circulator are described in U.S. Pat. No. 2,488,467, U.S. Pat. No. 2,433,795 and JP 56-167897. The fan of U.S. Pat. No. 2,433,795 has spiral slots in a rotating shroud instead of fan blades. The circulator fan disclosed in U.S. Pat. No. 2,488,467 emits air flow from a series of nozzles and has a large base including a motor and a blower or fan for creating the air flow.

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Locating fans such as those described above close to a user is not always possible as the bulky shape and structure mean that the fan occupies a significant amount of the user's work space area. In the particular case of a fan placed on, or close to, a desk the fan body or base reduces the area available for paperwork, a computer or other office equipment. Often multiple appliances must be located in the same area, close to a power supply point, and in close proximity to other appliances for ease of connection and in order to reduce the operating costs.

The shape and structure of a fan at a desk not only reduces the working area available to a user but can block natural light (or light from artificial sources) from reaching the desk area. A well lit desk area is desirable for close work and for reading. In addition, a well lit area can reduce eye strain and the related health problems that may result from prolonged periods working in reduced light levels.

SUMMARY OF THE INVENTION

A first aspect of the present invention provides a bladeless fan assembly for creating an air current, the fan assembly comprising a nozzle, a device for creating an air flow through the nozzle, the nozzle comprising an interior passage for receiving the air flow, a mouth through which the air flow is emitted, the mouth being defined by facing surfaces of the nozzle, and spacers for spacing apart the facing surfaces of the nozzle, the nozzle defining an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth.

Advantageously, by this arrangement an air current is generated and a cooling effect is created without requiring a bladed fan. The air current created by the fan assembly has the benefit of being an air flow with low turbulence and with a more linear air flow profile than that provided by other prior art devices. This can improve the comfort of a user receiving the air flow.

Advantageously, the use of spacers spacing apart the facing surfaces of the nozzle enables a smooth, even output of air flow to be delivered to a user's location without the user feeling a 'choppy' flow. The spacers of the fan assembly provide for reliable, reproducible manufacture of the nozzle of the fan assembly. This means that a user should not experience a variation in the intensity of the air flow over time due to product aging or a variation from one fan assembly to another fan assembly due to variations in manufacture. The invention provides a fan assembly delivering a suitable cooling effect that is directed and focussed as compared to the air flow produced by prior art fans.

In the following description of fans and, in particular a fan of the preferred embodiment, the term 'bladeless' is used to describe apparatus in which air flow is emitted or projected forwards from the fan assembly without the use of blades. By this definition a bladeless fan assembly can be considered to have an output area or emission zone absent blades or vanes from which the air flow is released or emitted in a direction appropriate for the user. A bladeless fan assembly may be supplied with a primary source of air from a variety of sources or devices such as pumps, generators, motors or other fluid transfer devices, which include rotating devices such as a motor rotor and a bladed impeller for generating air flow. The supply of air generated by the motor causes a flow of air to pass from the room space or environment outside the fan assembly through the interior passage to the nozzle and then out through the mouth.

Hence, the description of a fan assembly as bladeless is not intended to extend to the description of the power source and

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components such as motors that are required for secondary fan functions. Examples of secondary fan functions can include lighting, adjustment and oscillation of the fan.

In a preferred embodiment, the nozzle extends about an axis to define the opening, and the spacers comprise a plurality of spacers angularly spaced about said axis, preferably equally angularly spaced about the axis.

In a preferred embodiment the nozzle extends substantially cylindrically about the axis. This creates a region for guiding and directing the airflow output from all around the opening defined by the nozzle of the fan assembly. In addition the cylindrical arrangement creates an assembly with a nozzle that appears tidy and uniform. An uncluttered design is desirable and appeals to a user or customer. The preferred features and dimensions of the fan assembly result in a compact arrangement while generating a suitable amount of air flow from the fan assembly for cooling a user.

Preferably the nozzle extends by a distance of at least 5 cm in the direction of the axis. Preferably the nozzle extends about the axis by a distance in the range from 30 cm to 180 cm. This provides options for emission of air over a range of different output areas and opening sizes, such as may be suitable for cooling the upper body and face of a user when working at a desk, for example.

The nozzle preferably comprises an inner casing section and an outer casing section which define the interior passage, the mouth and the opening. Each casing section may comprise a plurality of components, but in the preferred embodiment each of these sections is formed from a single annular component.

In the preferred embodiment the spacers are mounted on, preferably integral with, one of the facing surfaces of the nozzle. Advantageously, the integral arrangement of the spacers with this surface can reduce the number of individual parts manufactured, thereby simplifying the process of part manufacture and part assembly, and thereby reducing the cost and complexity of the fan assembly. The spacers are preferably arranged to contact the other one of the facing surfaces.

The spacers are preferably arranged to maintain a set distance between the facing surfaces of the nozzle. This distance is preferably in the range from 0.5 to 5 mm. Preferably, one of the facing surfaces of the nozzle is biased towards the other of the facing surfaces, and so the spacers serve to hold apart the facing surfaces of the nozzle to maintain the set distance therebetween. This can ensure that the spacers engage said other one of the facing surfaces and thus can ensure that the desired spacing between the facing surfaces is achieved. The spacers can be located and orientated in any suitable position that enables the facing surfaces of the nozzle to be spaced apart as desired, without requiring further support or positioning members to set the desired spacing of the facing surfaces. Preferably the spacers comprise a plurality of spacers which are spaced about the opening. With this arrangement each one of the plurality of spacers can engage said other one of the facing surfaces such that a point of contact is provided between each spacer and the said other facing surface. The preferred number of spacers is in the range from 5 to 50.

In the fan assembly of the present invention as previously described, the nozzle may comprise a Coanda surface located adjacent the mouth and over which the mouth is arranged to direct the air flow. A Coanda surface is a known type of surface over which fluid flow exiting an output orifice close to the surface exhibits the Coanda effect. The fluid tends to flow over the surface closely, almost 'clinging to' or 'hugging' the surface. The Coanda effect is already a proven, well documented method of entrainment whereby a primary air flow is

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directed over the Coanda surface. A description of the features of a Coanda surface, and the effect of fluid flow over a Coanda surface, can be found in articles such as Reba, Scientific American, Volume 214, June 1963 pages 84 to 92.

Through use of a Coanda surface, air from outside the fan assembly is drawn through the opening by the air flow directed over the Coanda surface.

In the preferred embodiments an air flow is created through the nozzle of the fan assembly. In the following description this air flow will be referred to as primary air flow. The primary air flow exits the nozzle via the mouth and preferably passes over the Coanda surface. The primary air flow entrains the air surrounding the mouth of the nozzle, which acts as an air amplifier to supply both the primary air flow and the entrained air to the user. The entrained air will be referred to here as a secondary air flow. The secondary air flow is drawn from the room space, region or external environment surrounding the mouth of the nozzle and, by displacement, from other regions around the fan assembly. The primary air flow directed over the Coanda surface combined with the secondary air flow entrained by the air amplifier gives a total air flow emitted or projected forward to a user from the opening defined by the nozzle. The total air flow is sufficient for the fan assembly to create an air current suitable for cooling.

Preferably the nozzle comprises a loop. The shape of the nozzle is not constrained by the requirement to include space for a bladed fan. In a preferred embodiment the nozzle is annular or substantially annular. By providing an annular nozzle the fan can potentially reach a broad area. In a further preferred embodiment the nozzle is at least partially circular. This arrangement can provide a variety of design options for the fan, increasing the choice available to a user or customer. Furthermore, the nozzle can be manufactured as a single piece, reducing the complexity of the fan assembly and thereby reducing manufacturing costs.

In a preferred arrangement the nozzle comprises at least one wall defining the interior passage and the mouth, and the at least one wall comprises the facing surfaces defining the mouth. Preferably, the mouth has an outlet, and the spacing between the facing surfaces at the outlet of the mouth is in the range from 0.5 mm to 10 mm. By this arrangement a nozzle can be provided with the desired flow properties to guide the primary air flow over the surface and provide a relatively uniform, or close to uniform, total air flow reaching the user.

In the preferred fan assembly the device for creating an air flow through the nozzle comprises an impeller driven by a motor. This arrangement provides a fan with efficient air flow generation. More preferably the device for creating an air flow comprises a DC brushless motor and a mixed flow impeller. This can enable frictional losses from motor brushes to be reduced, and can avoid carbon debris from the brushes used in a traditional motor. Reducing carbon debris and emissions is advantageous in a clean or pollutant sensitive environment such as a hospital or around those with allergies. While induction motors, which are generally used in bladed fans, also have no brushes, a DC brushless motor can provide a much wider range of operating speeds than an induction motor.

The device for creating an air flow through the nozzle is preferably located in a base of the fan assembly. The nozzle is preferably mounted on the base.

In a second aspect the present invention provides a nozzle for a fan assembly, preferably a bladeless fan assembly, for creating an air current, the nozzle comprising an interior passage for receiving an air flow, a mouth through which the air flow is emitted, the mouth being defined by facing surfaces of the nozzle, and spacers for spacing apart the facing surfaces

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of the nozzle, the nozzle defining an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth.

Preferably, the nozzle comprises a Coanda surface located adjacent the mouth and over which the mouth is arranged to direct the air flow. In a preferred embodiment the nozzle comprises a diffuser located downstream of the Coanda surface. The diffuser directs the air flow emitted towards a user's location whilst maintaining a smooth, even output, generating a suitable cooling effect without the user feeling a 'choppy' flow.

The invention also provides a fan assembly comprising a nozzle as aforementioned.

The nozzle may be rotatable or pivotable relative to a base portion, or other portion, of the fan assembly. This enables the nozzle to be directed towards or away from a user as required. The fan assembly may be desk, floor, wall or ceiling mountable. This can increase the portion of a room over which the user experiences cooling.

Features described above in connection with the first aspect of the invention are equally applicable to the second aspect of the invention, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIG. 1 is a front view of a fan assembly;

FIG. 2 is a perspective view of a portion of the fan assembly of FIG. 1;

FIG. 3 is a side sectional view through a portion of the fan assembly of FIG. 1 taken at line A-A;

FIG. 4 is an enlarged side sectional detail of a portion of the fan assembly of FIG. 1;

FIG. 5 is an alternative arrangement shown as an enlarged side sectional detail of a portion of the fan assembly of FIG. 1; and

FIG. 6 is a sectional view of the fan assembly taken along line B-B of FIG. 3 and viewed from direction F of FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates an example of a fan assembly 100 viewed from the front of the device. The fan assembly 100 comprises an annular nozzle 1 defining a central opening 2. With reference also to FIGS. 2 and 3, nozzle 1 comprises an interior passage 10, a mouth 12 and a Coanda surface 14 adjacent the mouth 12. The Coanda surface 14 is arranged so that a primary air flow exiting the mouth 12 and directed over the Coanda surface 14 is amplified by the Coanda effect. The nozzle 1 is connected to, and supported by, a base 16 having an outer casing 18. The base 16 includes a plurality of selection buttons 20 accessible through the outer casing 18 and through which the fan assembly 100 can be operated. The fan assembly has a height, H, width, W, and depth, D, shown on FIGS. 1 and 3. The nozzle 1 is arranged to extend substantially orthogonally about the axis X. The height of the fan assembly, H, is perpendicular to the axis X and extends from the end of the base 16 remote from the nozzle 1 to the end of the nozzle 1 remote from the base 16. In this embodiment the fan assembly 100 has a height, H, of around 530 mm, but the fan assembly 100 may have any desired height. The base 16 and the nozzle 1 have a width, W, perpendicular to the height H and perpendicular to the axis X. The width of the base 16 is shown labelled W1 and the width of the nozzle 1 is shown labelled as W2 on FIG. 1. The base 16 and the nozzle 1 have

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a depth in the direction of the axis X. The depth of the base 16 is shown labelled D1 and the depth of the nozzle 1 is shown labelled as D2 on FIG. 3.

FIGS. 3, 4, 5 and 6 illustrate further specific details of the fan assembly 100. A motor 22 for creating an air flow through the nozzle 1 is located inside the base 16. The base 16 further comprises an air inlet 24a, 24b formed in the outer casing 18 and through which air is drawn into the base 16. A motor housing 28 for the motor 22 is also located inside the base 16. The motor 22 is supported by the motor housing 28 and held or fixed in a secure position within the base 16.

In the illustrated embodiment, the motor 22 is a DC brushless motor. An impeller 30 is connected to a rotary shaft extending outwardly from the motor 22, and a diffuser 32 is positioned downstream of the impeller 30. The diffuser 32 comprises a fixed, stationary disc having spiral blades.

An inlet 34 to the impeller 30 communicates with the air inlet 24a, 24b formed in the outer casing 18 of the base 16. The outlet 36 of the diffuser 32 and the exhaust from the impeller 30 communicate with hollow passageway portions or ducts located inside the base 16 in order to establish air flow from the impeller 30 to the interior passage 10 of the nozzle 1. The motor 22 is connected to an electrical connection and power supply and is controlled by a controller (not shown). Communication between the controller and the plurality of selection buttons 20 enables a user to operate the fan assembly 100.

The features of the nozzle 1 will now be described with reference to FIGS. 3, 4 and 5. The shape of the nozzle 1 is annular. In this embodiment the nozzle 1 has a diameter of around 350 mm, but the nozzle may have any desired diameter, for example around 300 mm. The interior passage 10 is annular and is formed as a continuous loop or duct within the nozzle 1. The nozzle 1 comprises a wall 38 defining the interior passage 10 and the mouth 12. In the illustrated embodiments the wall 38 comprises two curved wall parts 38a and 38b connected together, and hereafter collectively referred to as the wall 38. The wall 38 comprises an inner surface 39 and an outer surface 40. In the illustrated embodiments the wall 38 is arranged in a looped or folded shape such that the inner surface 39 and outer surface 40 approach and partially face, or overlap, one another. The facing portions of the inner surface 39 and the outer surface 40 define the mouth 12. The mouth 12 extends about the axis X and comprises a tapered region 42 narrowing to an outlet 44.

The wall 38 is stressed and held under tension with a preload force such that one of the facing portions of the inner surface 39 and the outer surface 40 is biased towards the other; in the preferred embodiments the outer surface 40 is biased towards the inner surface 39. These facing portions of the inner surface 39 and the outer surface 40 are held apart by spacers. In the illustrated embodiments the spacers comprise a plurality of spacers 26 which are preferably equally angularly spaced about the axis X. The spacers 26 are preferably integral with the wall 38 and are preferably located on the inner surface 39 of the wall 38 so as to contact the outer surface 40 and maintain a substantially constant spacing about the axis X between the facing portions of the inner surface 39 and the outer surface 40 at the outlet 44 of the mouth 12.

FIGS. 4 and 5 illustrate two alternative arrangements for the spacers 26. The spacers 26 illustrated in FIG. 4 comprise a plurality of fingers 260 each having an inner edge 264 and an outer edge 266. Each finger 260 is located between the facing portions of the inner surface 39 and the outer surface 40 of the wall 38. Each finger 260 is secured at its inner edge 264 to the inner surface 39 of the wall 38. A portion of the arm 260

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extends beyond the outlet 44. The outer edge 266 of arm 260 engages the outer surface 40 of the wall 38 to space apart the facing portions of the inner surface 39 and the outer surface 40.

The spacers illustrated in FIG. 5 are similar to those illustrated in FIG. 4, except that the fingers 360 of FIG. 5 terminate substantially flush with the outlet 44 of the mouth 12.

The size of the fingers 260, 360 determines the spacing between the facing portions of the inner surface 39 and the outer surface 40.

The spacing between the facing portions at the outlet 44 of the mouth 12 is chosen to be in the range from 0.5 mm to 10 mm. The choice of spacing will depend on the desired performance characteristics of the fan. In this embodiment the outlet 44 is around 1.3 mm wide, and the mouth 12 and the outlet 44 are concentric with the interior passage 10.

The mouth 12 is adjacent a surface comprising a Coanda surface 14. The surface of the nozzle 1 of the illustrated embodiment further comprises a diffuser portion 46 located downstream of the Coanda surface 14 and a guide portion 48 located downstream of the diffuser portion 46. The diffuser portion 46 comprises a diffuser surface 50 arranged to taper away from the axis X in such a way so as to assist the flow of air current delivered or output from the fan assembly 100. In the example illustrated in FIG. 3 the mouth 12 and the overall arrangement of the nozzle 1 is such that the angle subtended between the diffuser surface 50 and the axis X is around 15°. The angle is chosen for efficient air flow over the Coanda surface 14 and over the diffuser portion 46. The guide portion 48 includes a guide surface 52 arranged at an angle to the diffuser surface 50 in order to further aid efficient delivery of cooling air flow to a user. In the illustrated embodiment the guide surface 52 is arranged substantially parallel to the axis X and presents a substantially flat and substantially smooth face to the air flow emitted from the mouth 12.

The surface of the nozzle 1 of the illustrated embodiment terminates at an outwardly flared surface 54 located downstream of the guide portion 48 and remote from the mouth 12. The flared surface 54 comprises a tapering portion 56 and a tip 58 defining the circular opening 2 from which air flow is emitted and projected from the fan assembly 1. The tapering portion 56 is arranged to taper away from the axis X in a manner such that the angle subtended between the tapering portion 56 and the axis is around 45°. The tapering portion 56 is arranged at an angle to the axis which is steeper than the angle subtended between the diffuser surface 50 and the axis. A sleek, tapered visual effect is achieved by the tapering portion 56 of the flared surface 54. The shape and blend of the flared surface 54 detracts from the relatively thick section of the nozzle 1 comprising the diffuser portion 46 and the guide portion 48. The user's eye is guided and led, by the tapering portion 56, in a direction outwards and away from axis X towards the tip 58. By this arrangement the appearance is of a fine, light, uncluttered design often favoured by users or customers.

The nozzle 1 extends by a distance of around 5 cm in the direction of the axis. The diffuser portion 46 and the overall profile of the nozzle 1 are based, in part, on an aerofoil shape. In the example shown the diffuser portion 46 extends by a distance of around two thirds the overall depth of the nozzle 1 and the guide portion 48 extends by a distance of around one sixth the overall depth of the nozzle.

The fan assembly 100 described above operates in the following manner. When a user makes a suitable selection from the plurality of buttons 20 to operate or activate the fan assembly 100, a signal or other communication is sent to drive the motor 22. The motor 22 is thus activated and air is drawn

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into the fan assembly 100 via the air inlets 24a, 24b. In the preferred embodiment air is drawn in at a rate of approximately 20 to 30 litres per second, preferably around 27 l/s (litres per second). The air passes through the outer casing 18 and along the route illustrated by arrow F' of FIG. 3 to the inlet 34 of the impeller 30. The air flow leaving the outlet 36 of the diffuser 32 and the exhaust of the impeller 30 is divided into two air flows that proceed in opposite directions through the interior passage 10. The air flow is constricted as it enters the mouth 12, is channelled around and past spacers 26 and is further constricted at the outlet 44 of the mouth 12. The constriction creates pressure in the system. The motor 22 creates an air flow through the nozzle 16 having a pressure of at least 400 kPa. The air flow created overcomes the pressure created by the constriction and the air flow exits through the outlet 44 as a primary air flow.

The output and emission of the primary air flow creates a low pressure area at the air inlets 24a, 24b with the effect of drawing additional air into the fan assembly 100. The operation of the fan assembly 100 induces high air flow through the nozzle 1 and out through the opening 2. The primary air flow is directed over the Coanda surface 14, the diffuser surface 50 and the guide surface 52. The primary air flow is amplified by the Coanda effect and concentrated or focussed towards the user by the guide portion 48 and the angular arrangement of the guide surface 52 to the diffuser surface 50. A secondary air flow is generated by entrainment of air from the external environment, specifically from the region around the outlet 44 and from around the outer edge of the nozzle 1. A portion of the secondary air flow entrained by the primary air flow may also be guided over the diffuser surface 48. This secondary air flow passes through the opening 2, where it combines with the primary air flow to produce a total air flow projected forward from the nozzle 1.

The combination of entrainment and amplification results in a total air flow from the opening 2 of the fan assembly 100 that is greater than the air flow output from a fan assembly without such a Coanda or amplification surface adjacent the emission area.

The distribution and movement of the air flow over the diffuser portion 46 will now be described in terms of the fluid dynamics at the surface.

In general a diffuser functions to slow down the mean speed of a fluid, such as air, this is achieved by moving the air over an area or through a volume of controlled expansion. The divergent passageway or structure forming the space through which the fluid moves must allow the expansion or divergence experienced by the fluid to occur gradually. A harsh or rapid divergence will cause the air flow to be disrupted, causing vortices to form in the region of expansion. In this instance the air flow may become separated from the expansion surface and uneven flow will be generated. Vortices lead to an increase in turbulence, and associated noise, in the air flow which can be undesirable, particularly in a domestic product such as a fan.

In order to achieve a gradual divergence and gradually convert high speed air into lower speed air the diffuser can be geometrically divergent. In the arrangement described above, the structure of the diffuser portion 46 results in an avoidance of turbulence and vortex generation in the fan assembly.

The air flow passing over the diffuser surface 50 and beyond the diffuser portion 46 can tend to continue to diverge as it did through the passageway created by the diffuser portion 46. The influence of the guide portion 48 on the air flow is such that the air flow emitted or output from the fan opening is concentrated or focussed towards user or into a room. The net result is an improved cooling effect at the user.

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The combination of air flow amplification with the smooth divergence and concentration provided by the diffuser portion 46 and guide portion 48 results in a smooth, less turbulent output than that output from a fan assembly without such a diffuser portion 46 and guide portion 48.

The amplification and laminar type of air flow produced results in a sustained flow of air being directed towards a user from the nozzle 1. In the preferred embodiment the mass flow rate of air projected from the fan assembly 100 is at least 450 l/s, preferably in the range from 600 l/s to 700 l/s. The flow rate at a distance of up to 3 nozzle diameters (i.e. around 1000 to 1200 mm) from a user is around 400 to 500 l/s. The total air flow has a velocity of around 3 to 4 m/s (metres per second). Higher velocities are achievable by reducing the angle subtended between the surface and the axis X. A smaller angle results in the total air flow being emitted in a more focussed and directed manner. This type of air flow tends to be emitted at a higher velocity but with a reduced mass flow rate. Conversely, greater mass flow can be achieved by increasing the angle between the surface and the axis. In this case the velocity of the emitted air flow is reduced but the mass flow generated increases. Thus the performance of the fan assembly can be altered by altering the angle subtended between the surface and the axis X.

The invention is not limited to the detailed description given above. Variations will be apparent to the person skilled in the art. For example, the fan could be of a different height or diameter. The base and the nozzle of the fan could be of a different depth, width and height. The fan need not be located on a desk, but could be free standing, wall mounted or ceiling mounted. The fan shape could be adapted to suit any kind of situation or location where a cooling flow of air is desired. A portable fan could have a smaller nozzle, say 5 cm in diameter. The device for creating an air flow through the nozzle can be a motor or other air emitting device, such as any air blower or vacuum source that can be used so that the fan assembly can create an air current in a room. Examples include a motor such as an AC induction motor or types of DC brushless motor, but may also comprise any suitable air movement or air transport device such as a pump or other device for providing directed fluid flow to generate and create an air flow. Features of a motor may include a diffuser or a secondary diffuser located downstream of the motor to recover some of the static pressure lost in the motor housing and through the motor.

The outlet of the mouth may be modified. The outlet of the mouth may be widened or narrowed to a variety of spacings to maximise air flow. The spacers or spacers may be of any size or shape as required for the size of the outlet of the mouth. The spacers may include shaped portions for sound and noise reduction or delivery. The outlet of the mouth may have a uniform spacing, alternatively the spacing may vary around the nozzle. There may be a plurality of spacers, each having a uniform size and shape, alternatively each spacer, or any number of spacers, may be of different shapes and dimensions. The spacers may be integral with a surface of the nozzle or may be manufactured as one or more individual parts and secured to the nozzle or surface of the nozzle by gluing or by fixings such as bolts or screws or snap fastenings, other suitable fixing means may be used. The spacers may be located at the mouth of the nozzle, as described above, or may be located upstream of the mouth of the nozzle. The spacers may be manufactured from any suitable material, such as a plastic, resin or a metal.

The air flow emitted by the mouth may pass over a surface, such as Coanda surface, alternatively the airflow may be emitted through the mouth and be projected forward from the

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fan assembly without passing over an adjacent surface. The Coanda effect may be made to occur over a number of different surfaces, or a number of internal or external designs may be used in combination to achieve the flow and entrainment required. The diffuser portion may be comprised of a variety of diffuser lengths and structures. The guide portion may be a variety of lengths and be arranged at a number of different positions and orientations to as required for different fan requirements and different types of fan performance. The effect of directing or concentrating the effect of the airflow can be achieved in a number of different ways; for example the guide portion may have a shaped surface or be angled away from or towards the centre of the nozzle and the axis X.

Other shapes of nozzle are envisaged. For example, a nozzle comprising an oval, or 'racetrack' shape, a single strip or line, or block shape could be used. The fan assembly provides access to the central part of the fan as there are no blades. This means that additional features such as lighting or a clock or LCD display could be provided in the opening defined by the nozzle.

Other features could include a pivotable or tiltable base for ease of movement and adjustment of the position of the nozzle for the user.

The invention claimed is:

1. A bladeless fan assembly for creating an air current, the fan assembly comprising a nozzle mounted on a base for creating an air flow through the nozzle, the nozzle comprising an interior passage for receiving the air flow from the base, a mouth through which the air flow is emitted, the mouth being defined by first and second facing surfaces of the nozzle, and a plurality of spacers for spacing apart the facing surfaces of the nozzle, the nozzle defining an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth, wherein the spacers are integral with the first facing surface, one of the facing surfaces of the nozzle is biased towards the other of the facing surfaces so that the spacers contact the second facing surface to space apart the facing surfaces, and the biasing occurs independently of the spacers.

2. The fan assembly of claim 1, wherein the nozzle extends about an axis to define said opening, and wherein the spacers are angularly spaced about said axis, preferably equally angularly spaced about said axis.

3. The fan assembly of claim 2, wherein the nozzle extends substantially cylindrically about the axis.

4. The fan assembly of claim 2, wherein the nozzle extends by a distance of at least 5 cm in the direction of the axis.

5. The fan assembly of claim 2, wherein the nozzle extends about the axis by a distance in the range from 30 cm to 180 cm.

6. The fan assembly of claim 1, wherein the number of spacers is in the range of 5 to 50.

7. The fan assembly of claim 1, wherein the nozzle comprises a loop.

8. The fan assembly of claim 1, wherein the nozzle is substantially annular.

9. The fan assembly of claim 1, wherein the nozzle is at least partially circular.

10. The fan assembly of claim 1, wherein the nozzle comprises at least one wall defining the interior passage and the mouth, and wherein said at least one wall comprises the facing surfaces defining the mouth.

11. The fan assembly of claim 1, wherein the mouth has an outlet, and the spacing between the facing surfaces at the outlet of the mouth is in the range from 0.5 mm to 10 mm.

12. The fan assembly of claim 1, wherein the base comprises an impeller driven by a motor.

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13. The fan assembly of claim 12, wherein the base comprises a DC brushless motor and a mixed flow impeller.

14. A nozzle for a bladeless fan assembly for creating an air current, the nozzle comprising an interior passage for receiving an air flow, a mouth through which the air flow is emitted, the mouth being defined by first and second facing surfaces of the nozzle, and a plurality of spacers for spacing apart the facing surfaces of the nozzle, the nozzle defining an opening through which air from outside the fan assembly is drawn by the air flow emitted from the mouth, wherein the spacers are integral with the first facing surface, one of the facing surfaces of the nozzle is biased towards the other of the facing surfaces so that the spacers contact the second facing surface to space apart the spacing surfaces, and the biasing occurs independently of the spacers.

15. The nozzle of claim 14, wherein the nozzle comprises a Coanda surface located adjacent the mouth and over which the mouth is arranged to direct the air flow.

16. The nozzle of claim 15, wherein the nozzle comprises a diffuser located downstream of the Coanda surface.

17. The nozzle of claim 14, wherein the nozzle extends about an axis to define said opening, and wherein the plurality of spacers are angularly spaced about said axis, preferably equally angularly spaced about said axis.

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18. The nozzle of claim 17, wherein the nozzle extends substantially cylindrically about the axis.

19. The nozzle of claim 17, wherein the nozzle extends by a distance of at least 5 cm in the direction of the axis.

20. The nozzle of claim 17, wherein the nozzle extends about the axis by a distance in the range from 30 cm to 180 cm.

21. The nozzle of claim 14 or 15, wherein the plurality of spacers comprises between 5 to 50 spacers.

22. The nozzle of claim 14 or 15, wherein the nozzle comprises a loop.

23. The nozzle of claim 14 or 15, wherein the nozzle is substantially annular.

24. The nozzle of claim 14 or 15, wherein the nozzle is at least partially circular.

25. The nozzle of claim 14 or 15, wherein the nozzle comprises at least one wall defining the interior passage and the mouth, and wherein said at least one wall comprises the facing surfaces defining the mouth.

26. The nozzle of claim 14 or 15, wherein the mouth has an outlet, and the spacing between the facing surfaces at the outlet of the mouth is in the range from 0.5 mm to 10 mm.

* * * * *

EXHIBIT D



US00D643098S

(12) **United States Design Patent**
Wallace et al.

(10) **Patent No.:** **US D643,098 S**
(45) **Date of Patent:** **** Aug. 9, 2011**

(54) **FAN HEATER**

(75) Inventors: **John David Wallace**, Malmesbury (GB);
Chang Hin Choong, Johor Bahru (MY);
Peter David Gammack, Malmesbury
(GB); **James Dyson**, Malmesbury (GB)

(73) Assignee: **Dyson Limited**, Malmesbury (GB)

(**) Term: **14 Years**

(21) Appl. No.: **29/385,595**

(22) Filed: **Feb. 16, 2011**

(30) **Foreign Application Priority Data**

Sep. 1, 2010 (GB) 4016850

(51) **LOC (9) Cl.** **23-03**

(52) **U.S. Cl.** **D23/342**

(58) **Field of Classification Search** D23/332-350;
392/360, 365-369, 373-376; 126/110 B,
126/90 A, 92 A

See application file for complete search history.

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Primary Examiner — T. Chase Nelson

Assistant Examiner — Eric Goodman

(74) *Attorney, Agent, or Firm* — Morrison & Foerster LLP

(57) **CLAIM**

We claim the ornamental design for a fan heater, as shown and described.

DESCRIPTION

FIG. 1 is a perspective view of a fan heater showing our new design;

FIG. 2 is a front view thereof;

FIG. 3 is a side view thereof;

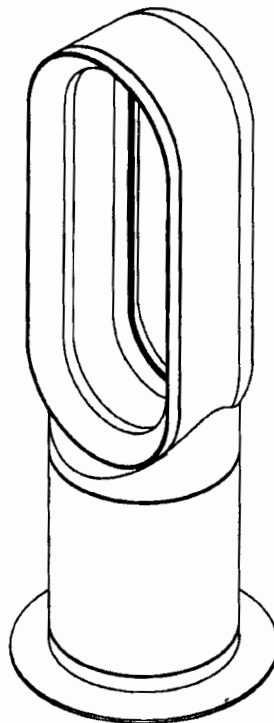
FIG. 4 is a side view from the side opposite that of FIG. 3;

FIG. 5 is a rear view thereof;

FIG. 6 is a plan view thereof from above; and,

FIG. 7 is a plan view thereof from below.

1 Claim, 6 Drawing Sheets



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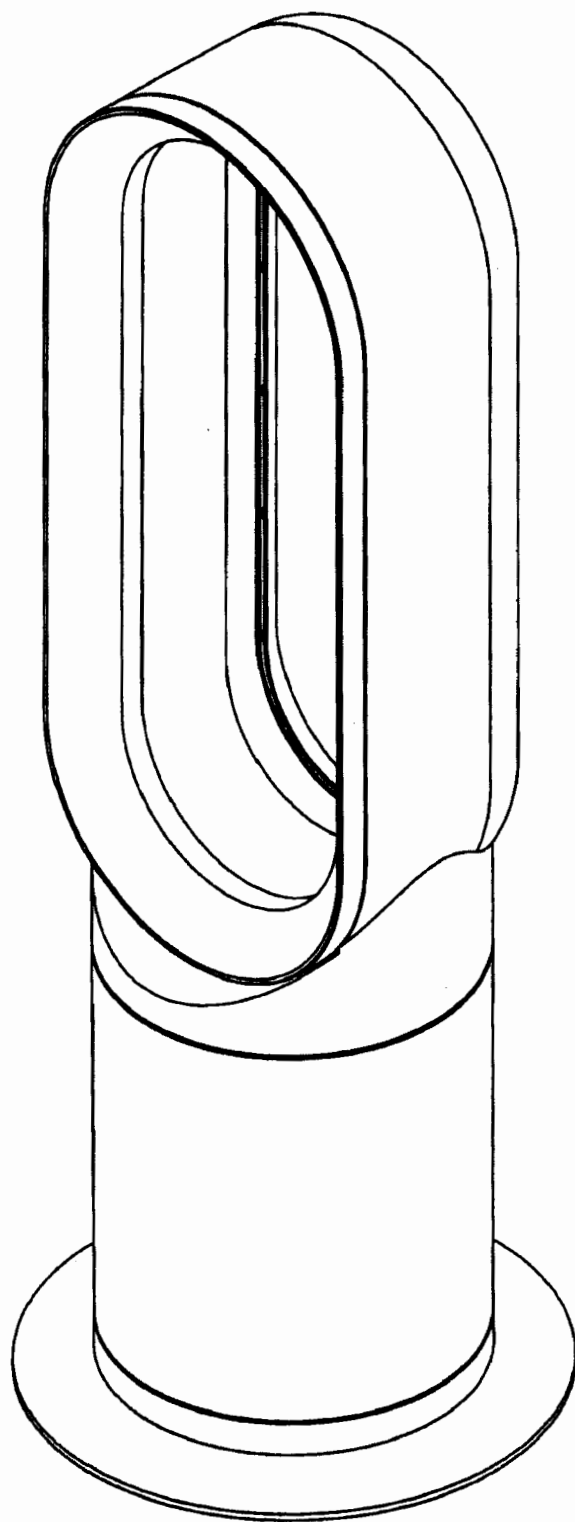


FIG. 1

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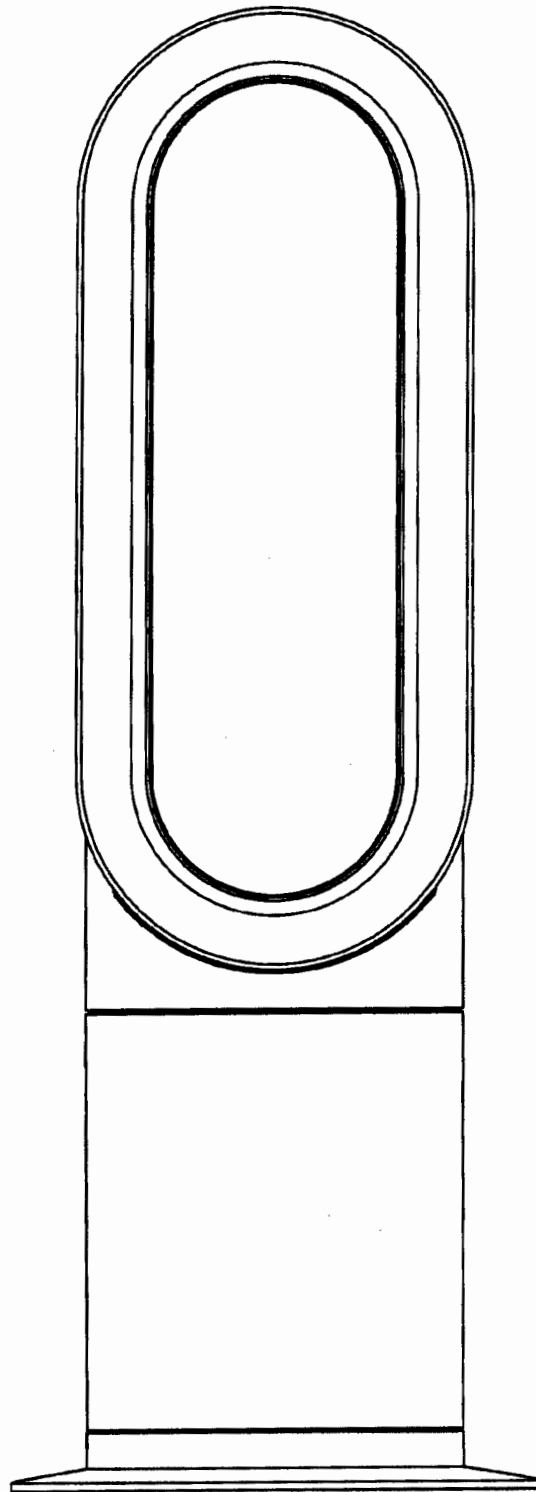


FIG. 2

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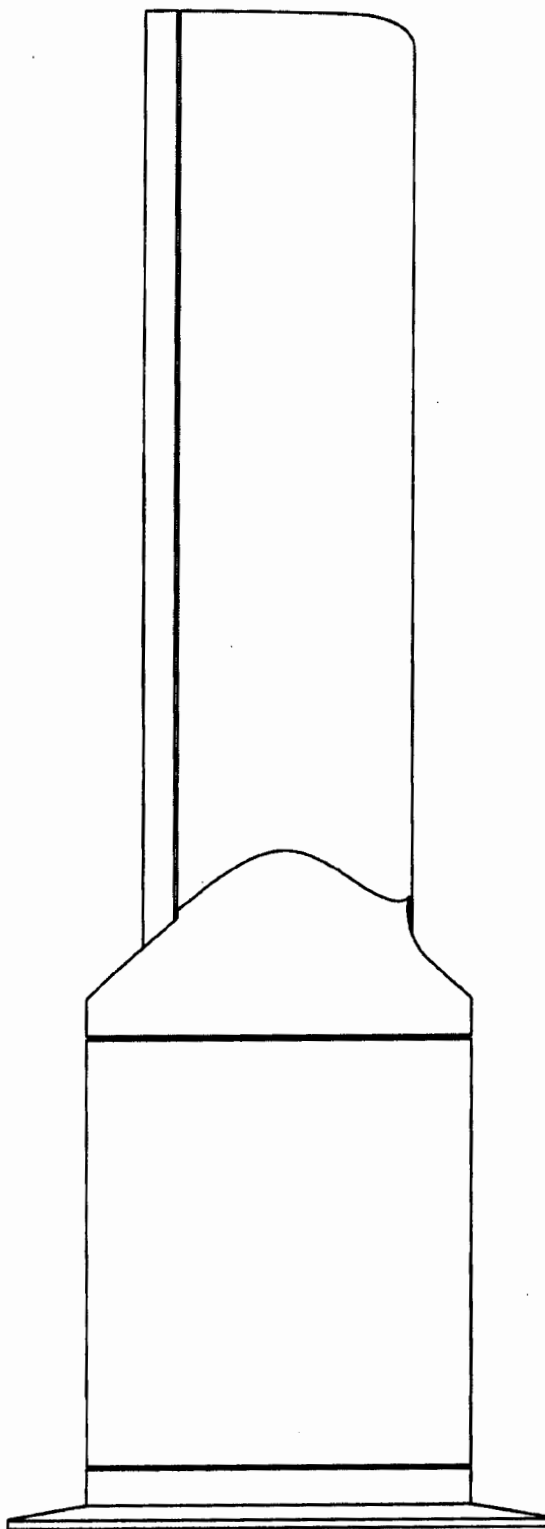


FIG. 3

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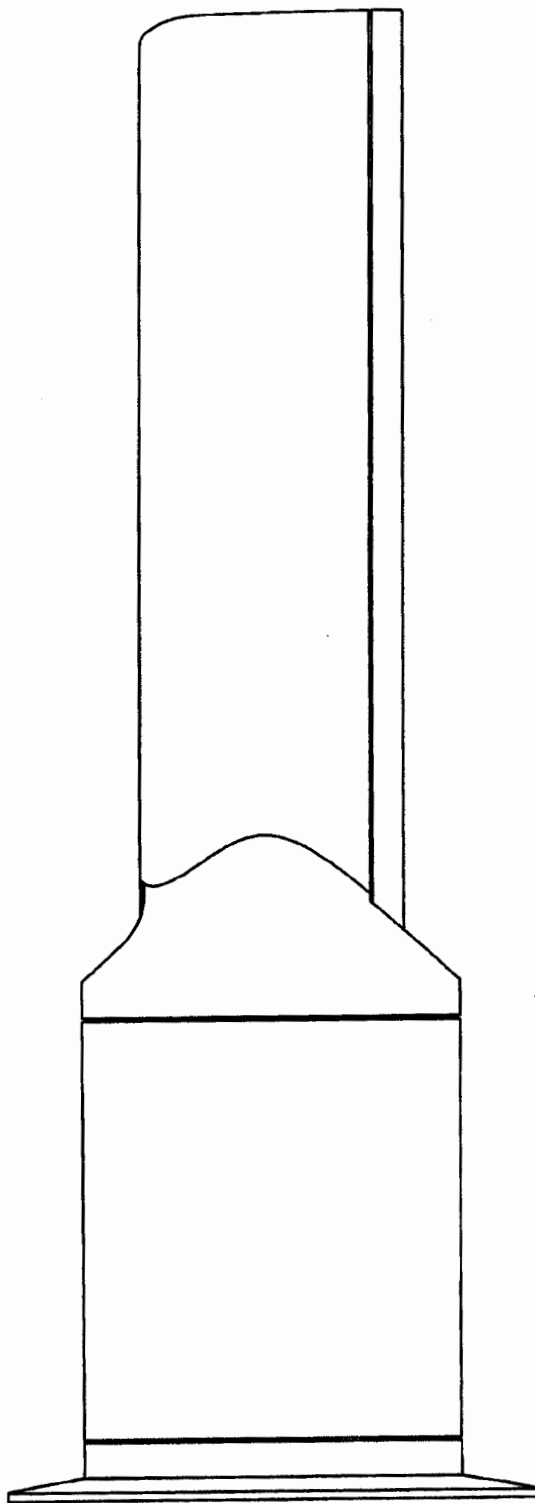


FIG. 4

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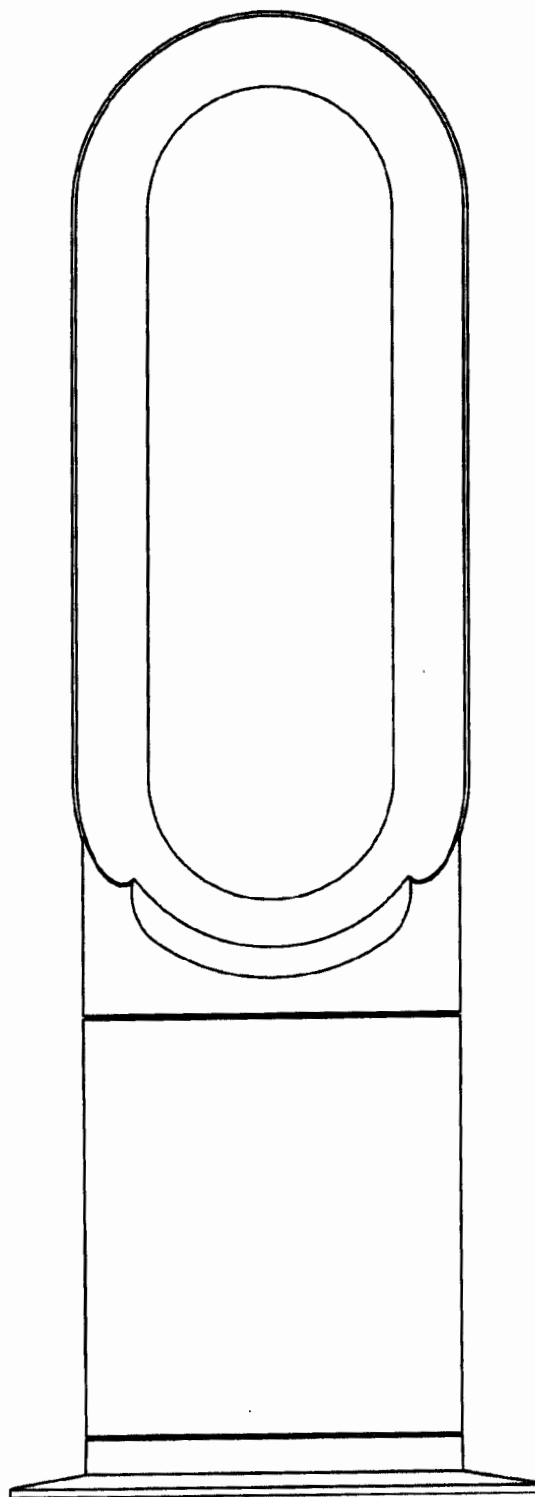


FIG. 5

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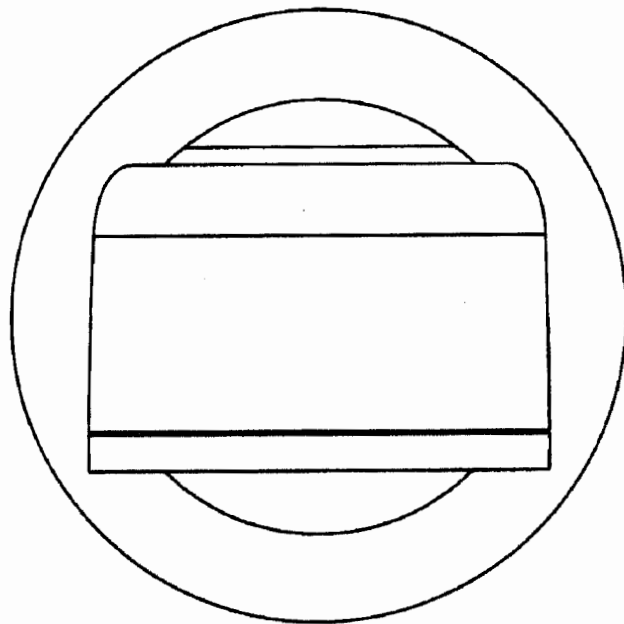


FIG. 6

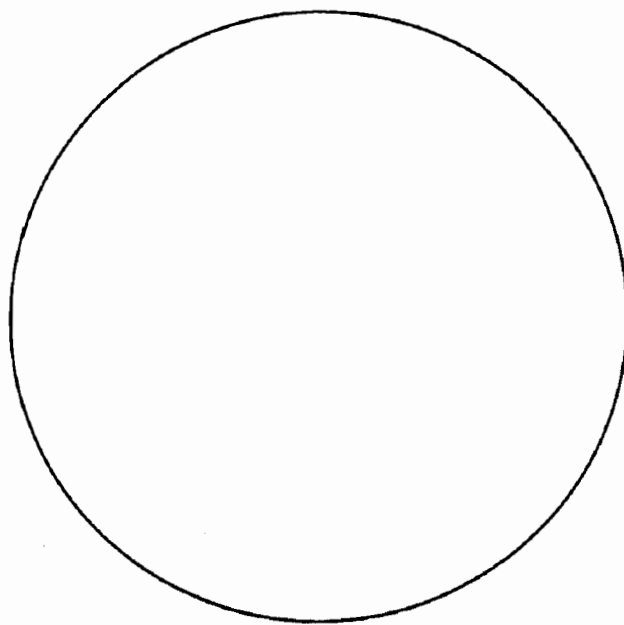


FIG. 7

EXHIBIT E



US00D672023S

(12) **United States Design Patent**
Wallace et al.

(10) **Patent No.:** **US D672,023 S**
(45) Date of Patent: **** Dec. 4, 2012**

(54) **FAN HEATER**

(75) Inventors: **John David Wallace**, Malmesbury (GB);
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(73) Assignee: **Dyson Technology Limited**,
Malmesbury (GB)

(**) **Term:** **14 Years**

(21) **Appl. No.:** **29/385,535**

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(52) **U.S. Cl.** **D23/370; D23/332; D23/378**

(58) **Field of Classification Search** D6/309;
D13/179; D23/370-386, 411-414, 328,
D23/330, 332, 333, 335-337, 341; 165/80.3,
165/120-122, 900; 310/12.13, 26, 52, 58,
310/60 A, 60 R, 61-65, 112, 125, 156.35-156.37,
310/157, 211, 261.1, 266, 268; 361/679.48,
361/694-697; 392/365, 373, 382, 383; 415/60,
415/66, 68, 175-178, 206, 208.1, 211.2,
415/213.1, 214.1, 215.1; 416/179, 185, 186 R,
416/187, 244 R, 246, 247 R

See application file for complete search history.

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Primary Examiner — Garth Rademaker

(74) *Attorney, Agent, or Firm* — Morrison & Foerster LLP

(57) **CLAIM**

We claim the ornamental design for a fan heater, as shown and described.

DESCRIPTION

FIG. 1 is a front perspective view of a fan heater showing our new design;

FIG. 2 is a side view thereof;

FIG. 3 is an opposite side view thereof;

FIG. 4 is a top plan view thereof;

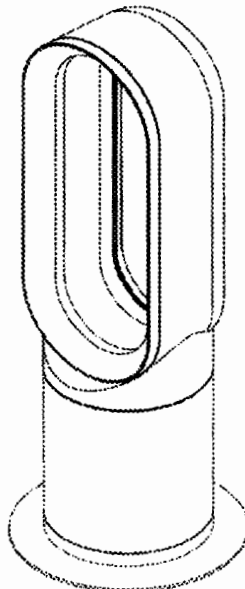
FIG. 5 is a bottom plan view thereof;

FIG. 6 is a front view thereof; and,

FIG. 7 is a rear view thereof.

The details shown in broken lines illustrate a base of the fan heater and form no part of the claimed design.

1 Claim, 6 Drawing Sheets



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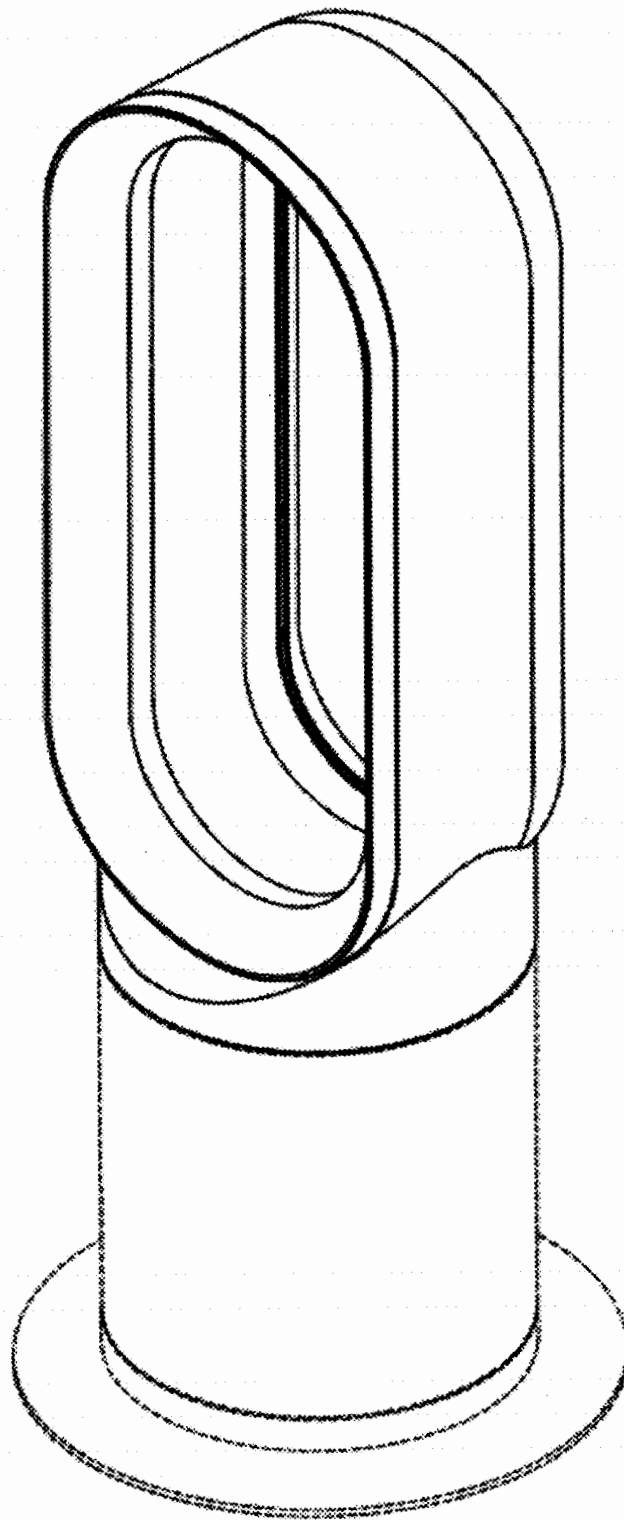


FIG. 1

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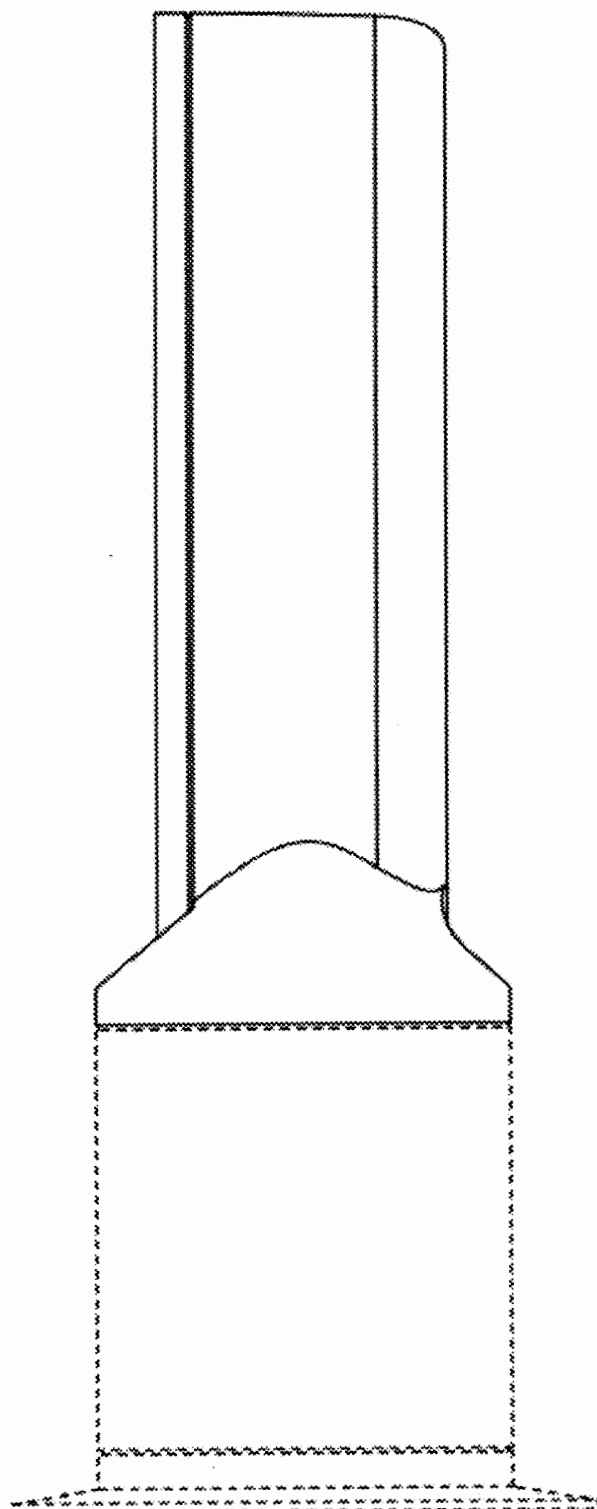


FIG. 2

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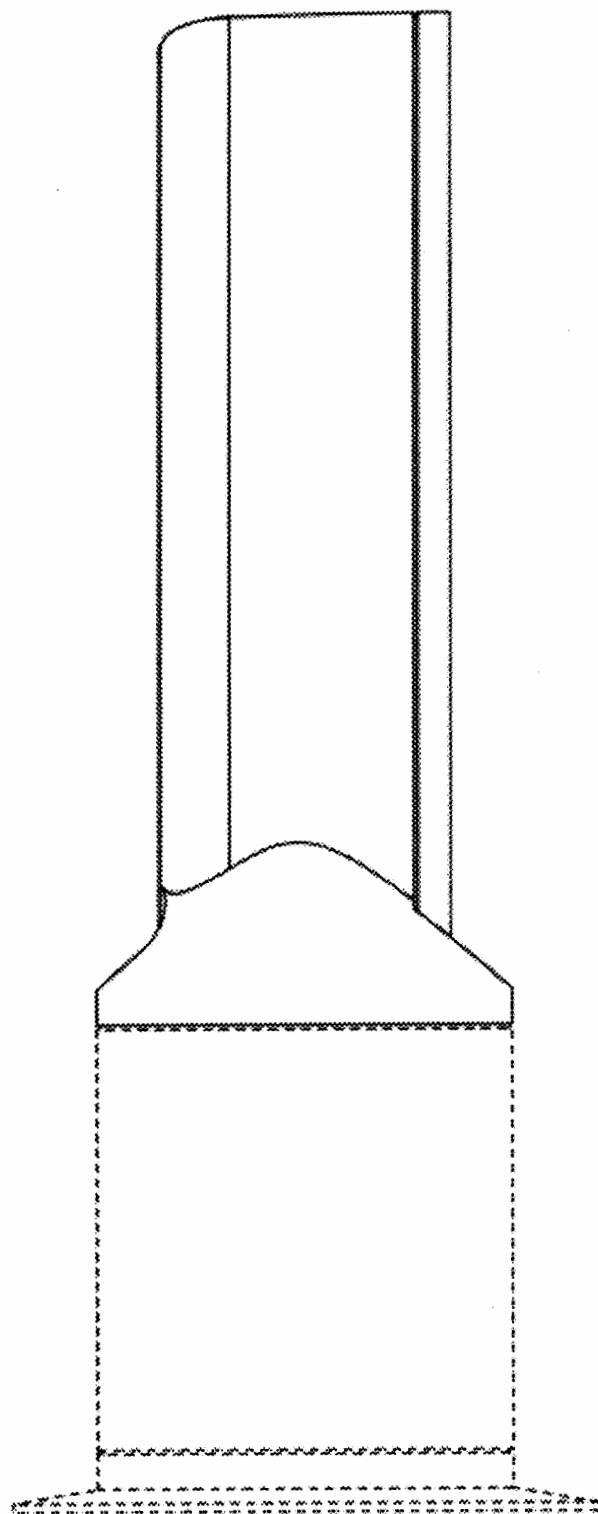


FIG. 3

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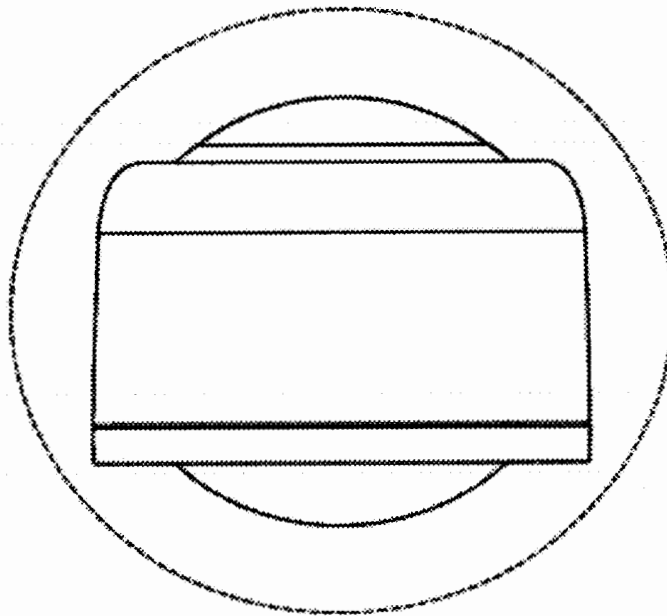


FIG. 4

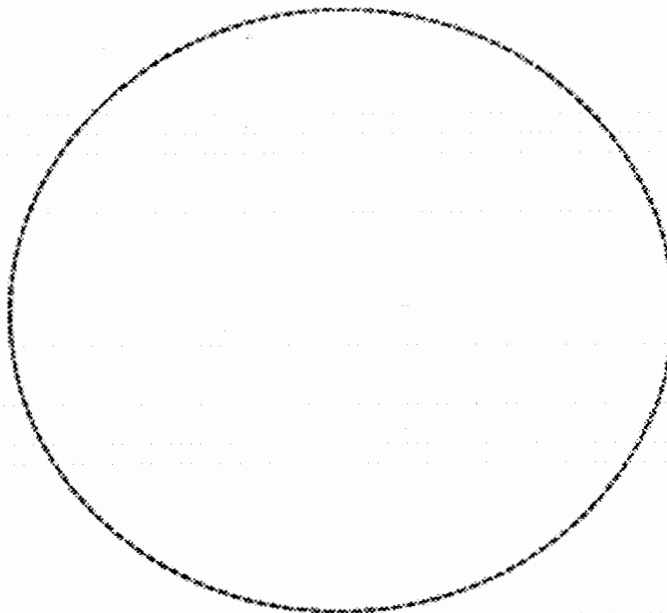


FIG. 5

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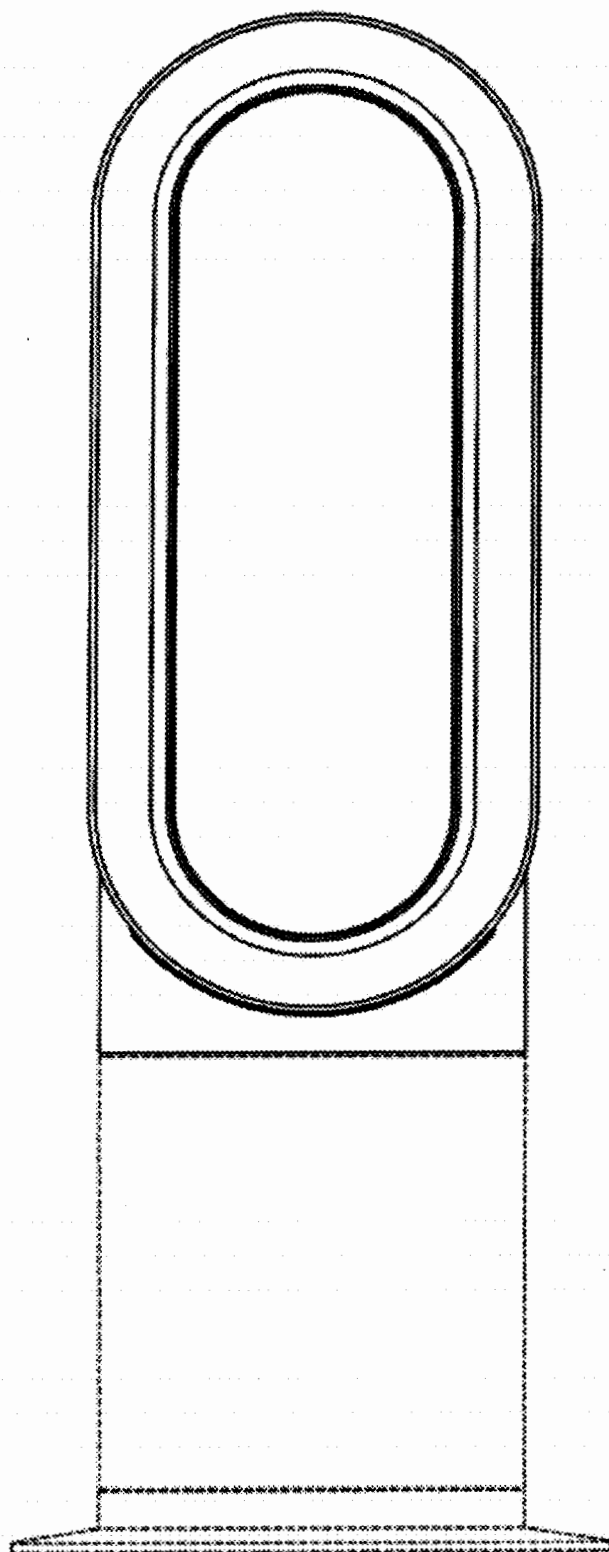


FIG. 6

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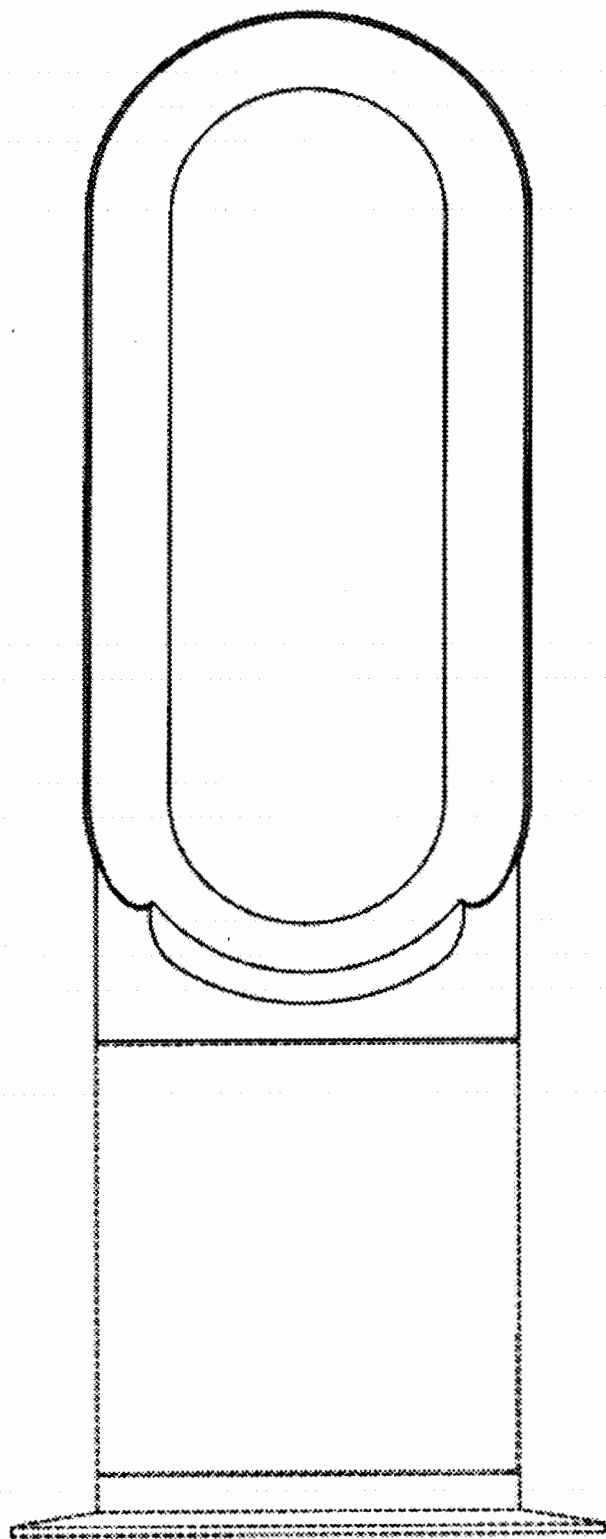


FIG. 7

EXHIBIT F

Dyson Copyright Registrations

Product Title	Registration No.	Registration Date
Dyson AM01 Diagram Tilt	VA 1-860-295	April 30, 2013
Dyson AM01 Image Cleaning	VA 1-860-302	April 26, 2013
Dyson AM01 Image Safety	VA 1-860-307	April 25, 2013
Dyson AM01 Image Speed Control	VA 1-860-305	April 25, 2013
Dyson Choppy Air	VA 1-860-316	April 30, 2013
Dyson Smooth Air	VA 1-860-304	April 30, 2013
Dyson AM01 Airflow Arrows 1 X 15	VA 1-860-300	April 26, 2013